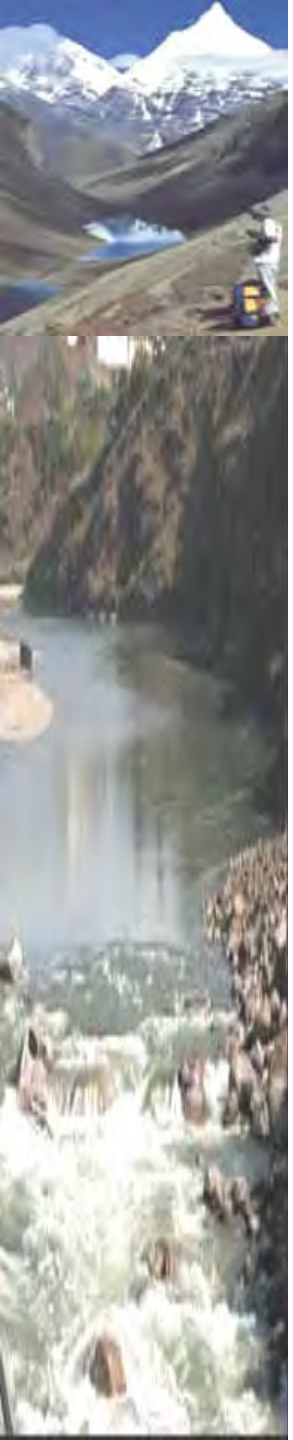
An Overview of National Center for Hydrology and Meteorology (NCHM)

Royal Government of Bhutan

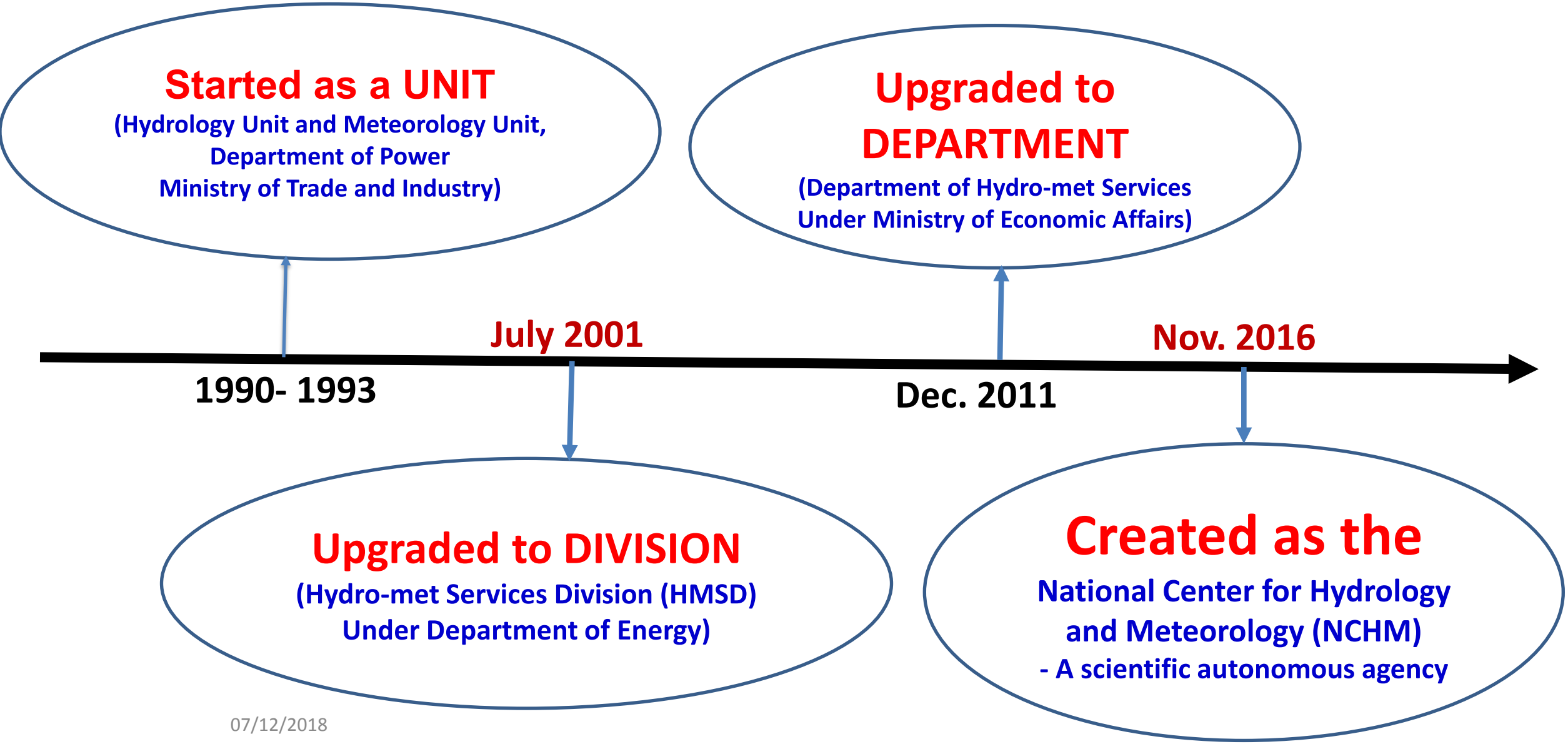
www.nchm.gov.bt



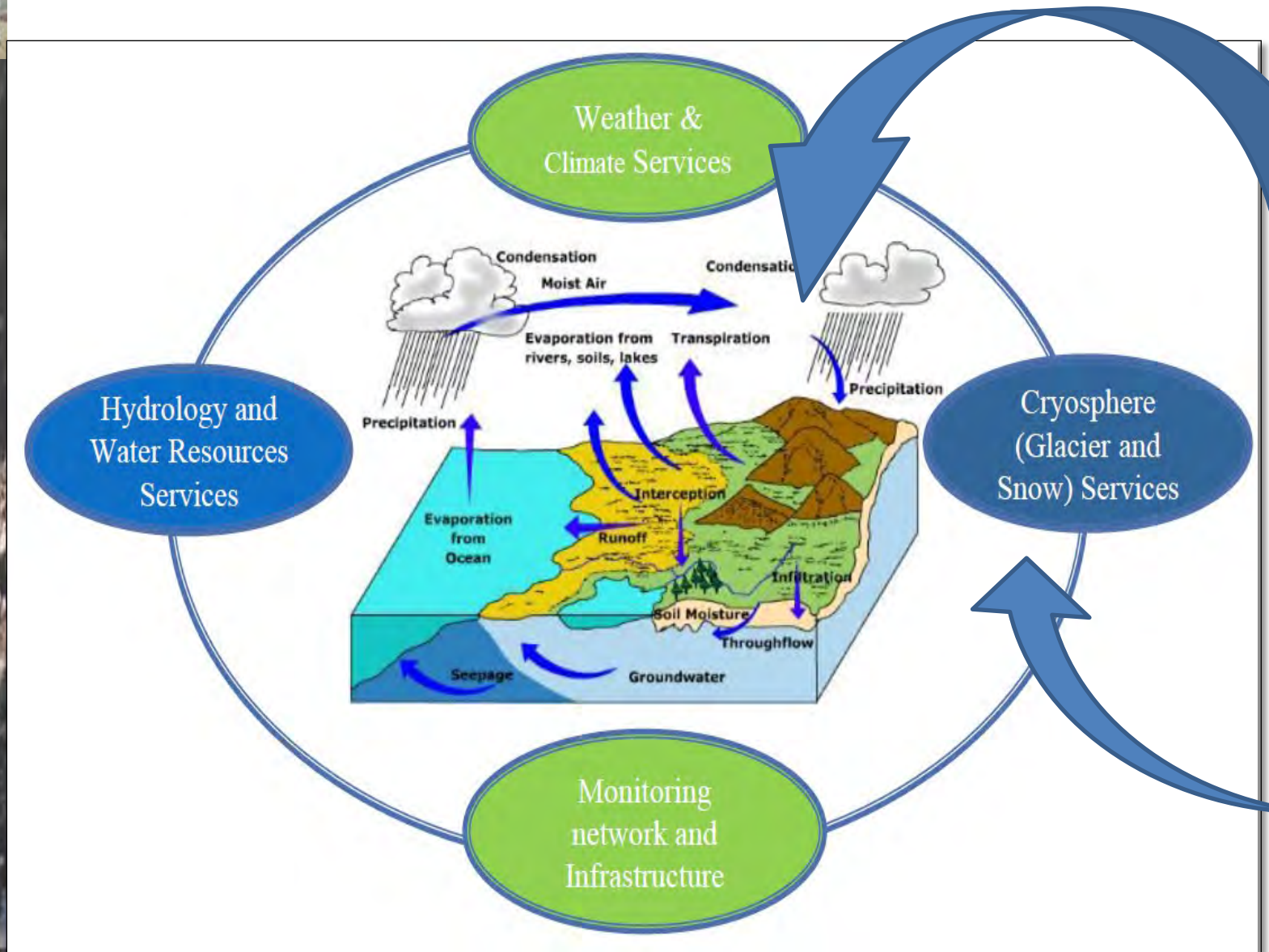
Presentation Outline

- Background and Services
- Hazards and vulnerability
- Challenges
- Hydro met Modernization Plans
- Linkage with FYP

Institutional Development of Hydro-met Services in Bhutan

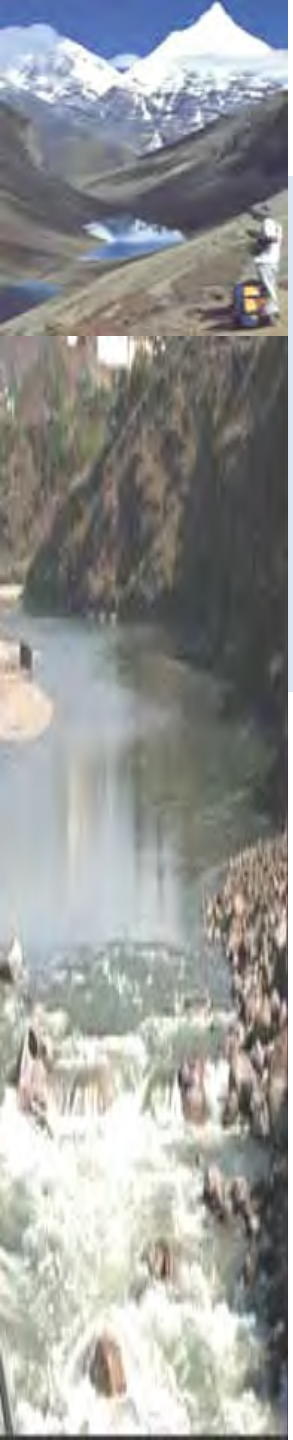


National Center for Hydrology and Meteorology (NCHM)



Aviation met from Department Air Transport MoIC)

Glaciology from Department of Geology and Mines (DGM), MoEA



National Center for Hydrology and Meteorology (NCHM) Mandate

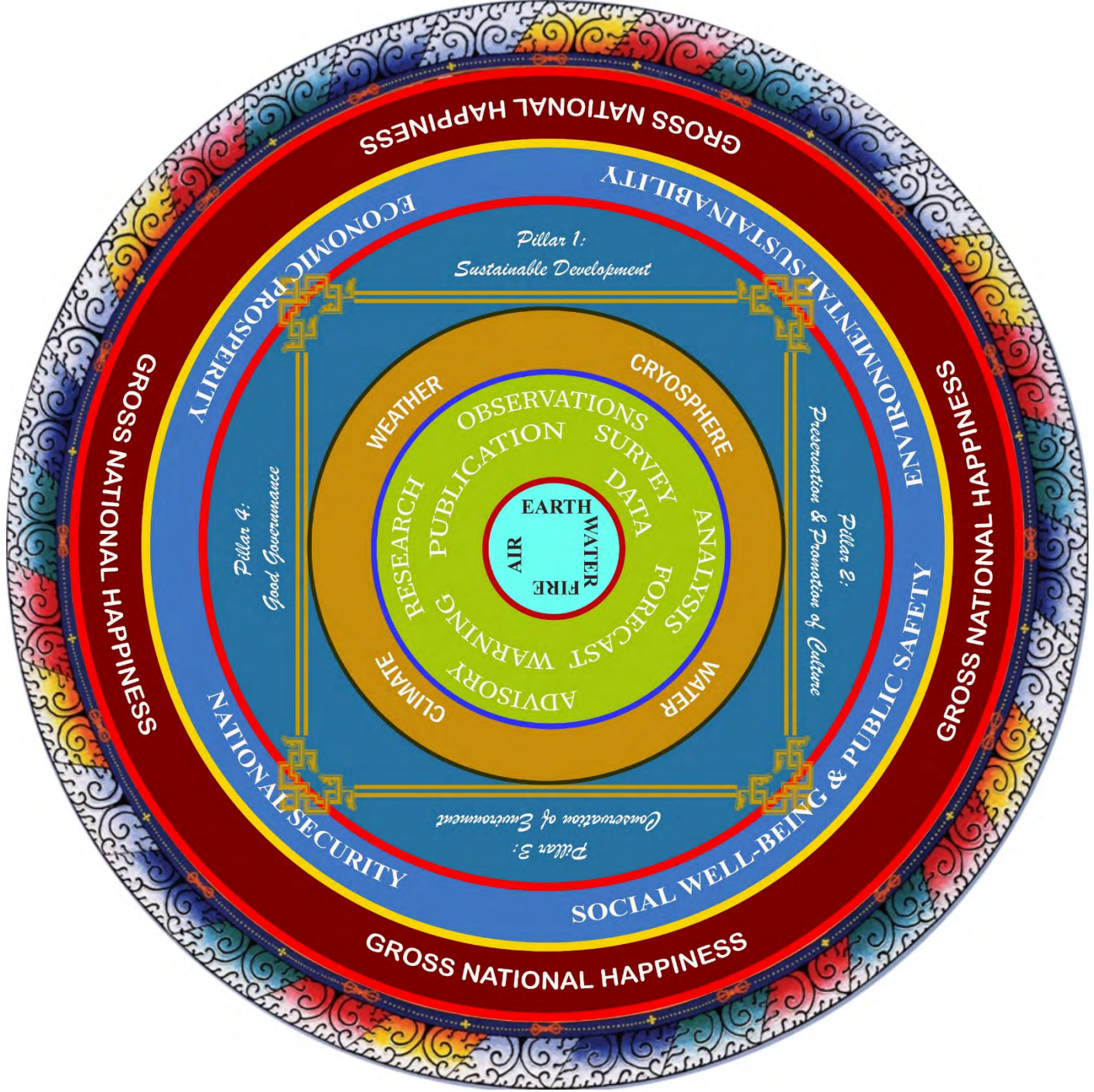
MANDATE

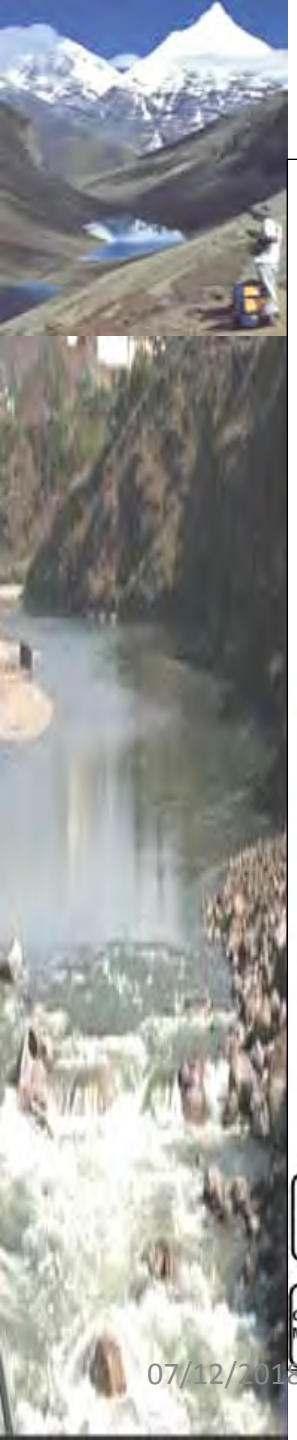
An autonomous scientific/technical agency to

"Provide scientific and technological services in hydrology, water resources, meteorology, climatology, and cryosphere to ensure the safety and socio-economic well-being of people and to support national and international needs".

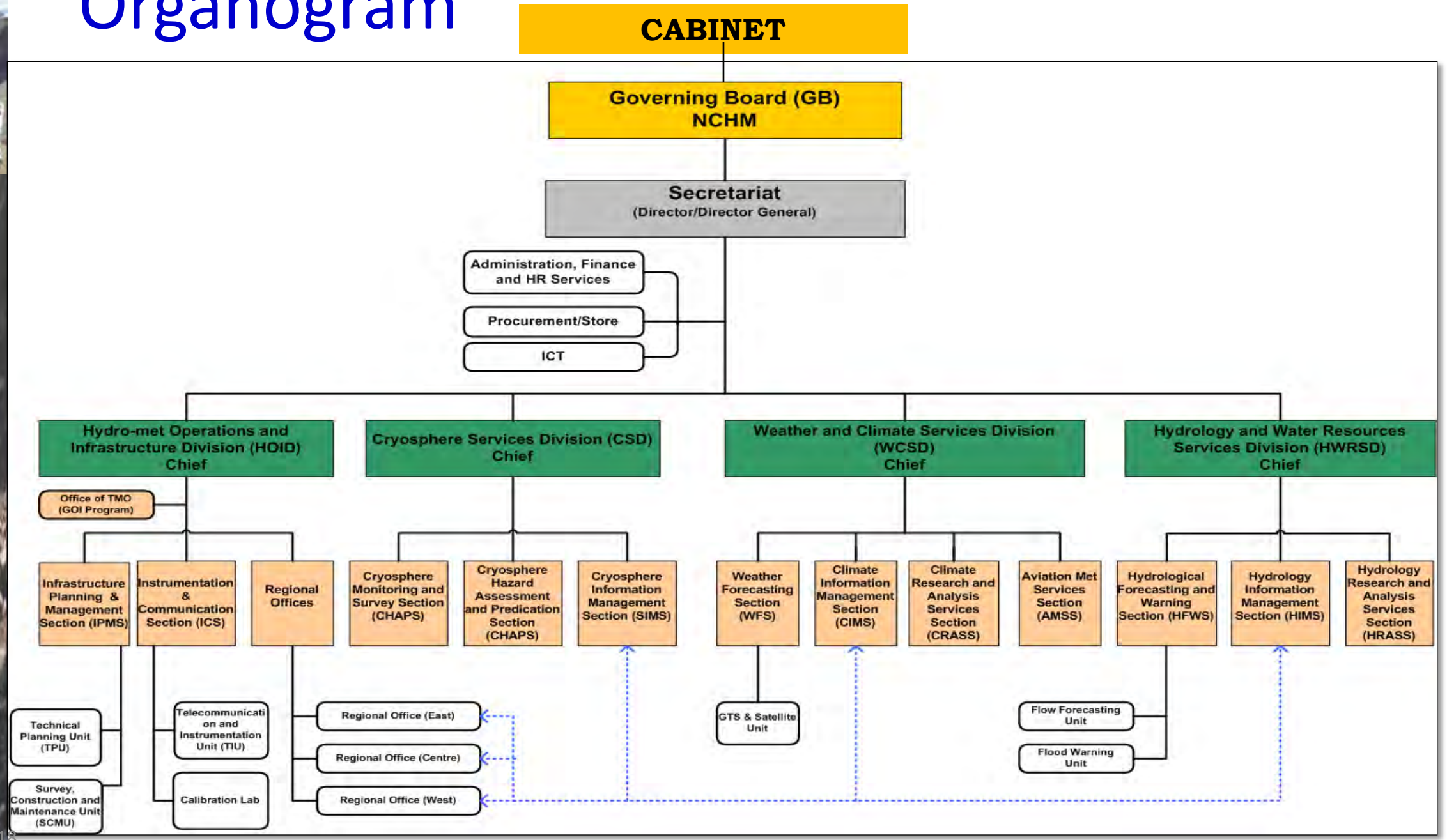
MISSION

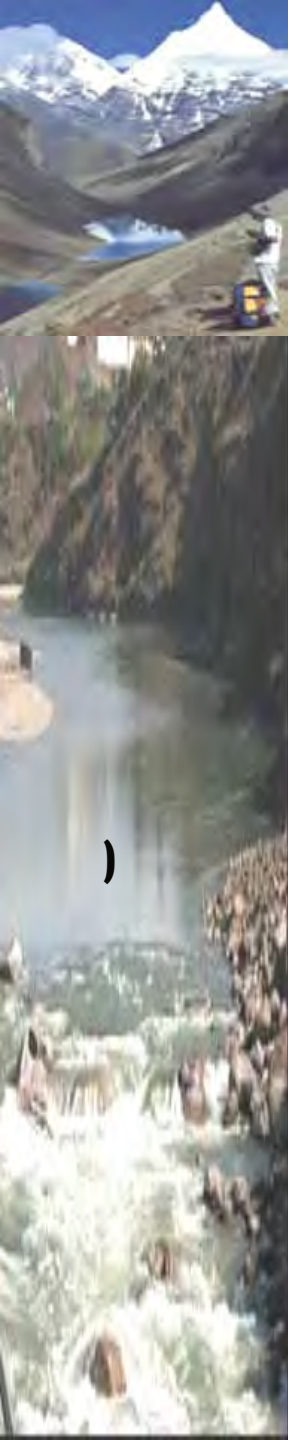
Monitoring and understanding of hydrology, weather, climate and cryosphere, for timely provision of information and services to protect lives and property and support national needs for ecologically balanced sustainable development.


GROSS NATIONAL HAPPINESS
ECONOMIC PROSPERITY
ENVIRONMENTAL SUSTAINABILITY
GROSS NATIONAL HAPPINESS
GROSS NATIONAL HAPPINESS
NATIONAL SECURITY
SOCIAL WELL-BEING & PUBLIC SAFETY
GROSS NATIONAL HAPPINESS
Pillar 1:
Sustainable Development
Pillar 2:
Preservation & Promotion of Culture
Pillar 3:
Conservation of Environment
Pillar 4:
Good Governance
WEATHER
CRYOSPHERE
CLIMATE
WATER
OBSERVATIONS
SURVEY
DATA
ANALYSIS
FORECAST
WARNING
ADVISORY
PUBLICATION
RESEARCH
EARTH
AIR
WATER
FIRE



Organogram


CABINET
Governing Board (GB)
NCHM
Secretariat
(Director/Director General)
Administration, Finance and HR Services
Procurement/Store
ICT
Hydro-met Operations and Infrastructure Division (HOID)
Chief
Cryosphere Services Division (CSD)
Chief
Weather and Climate Services Division (WCSD)
Chief
Hydrology and Water Resources Services Division (HWRSD)
Chief
Office of TMO (GOI Program)
Infrastructure Planning & Management Section (IPMS)
Instrumentation & Communication Section (ICS)
Regional Offices
Cryosphere Monitoring and Survey Section (CHAPS)
Cryosphere Hazard Assessment and Predication Section (CHAPS)
Cryosphere Information Management Section (SIMS)
Weather Forecasting Section (WFS)
Climate Information Management Section (CIMS)
Climate Research and Analysis Services Section (CRASS)
Aviation Met Services Section (AMSS)
Hydrological Forecasting and Warning Section (HFWS)
Hydrology Information Management Section (HIMS)
Hydrology Research and Analysis Services Section (HRASS)
Technical Planning Unit (TPU)
Survey, Construction and Maintenance Unit (SCMU)
Telecommunication and Instrumentation Unit (TIU)
Calibration Lab
Regional Office (East)
Regional Office (Centre)
Regional Office (West)
GTS & Satellite Unit
Flow Forecasting Unit
Flood Warning Unit

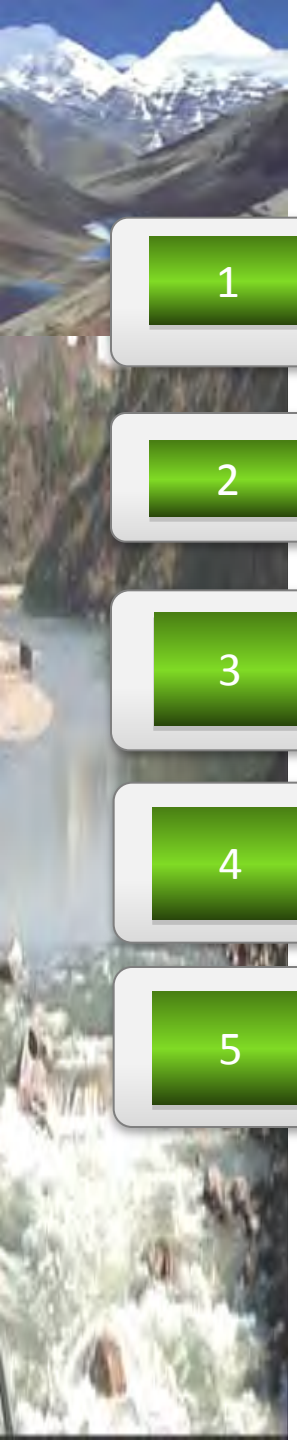


Governance of NCHM

The Center is governed by a Governing Board (GB) with its members from nominated from the relevant sectors approved by the Cabinet.

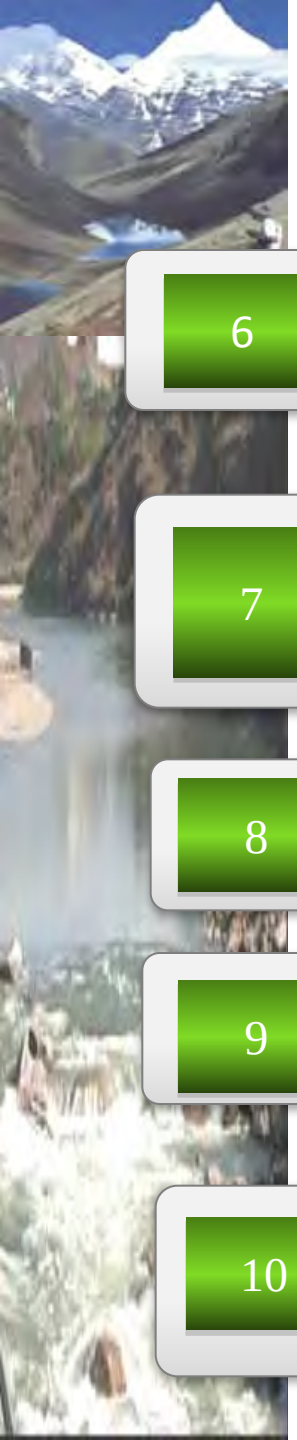
GB composition:

1. National Environment Commission (NEC);
2. Department of Hydro Power and Power Systems (DHPS), MoEA;
3. Department of Disaster Management (DDM), MoHCA;
4. Department of Public Health (DoPH), MoH;
5. Department of Human Settlement (DHS), MoWHS;
6. Department of Agriculture (DoA), MoAF; and
7. National Center for Hydrology and Meteorology (NCHM)



Core Functions

1. Monitoring and Observation of weather, water and climatic conditions
2. Public Weather Services (PWS)
3. Early Warning Services (Rainstorm and GLOF)
4. Climate Services (Historical, forecasting, Predictions, Projections,climatology)
5. Agrometeorological Services



Core Functions…….

6. Aviation Meteorological Services
7. Hydrology and Water Resource Services (Flow and Flood forecasting, Water Resource Assesments)
8. Monitoring of Snow, Glaciers and Glacial lakes
9. Advisories and bulletins of extreme events (Cyclone, Wind storm etc..)
10. Provision of high quality climate and hydrology data

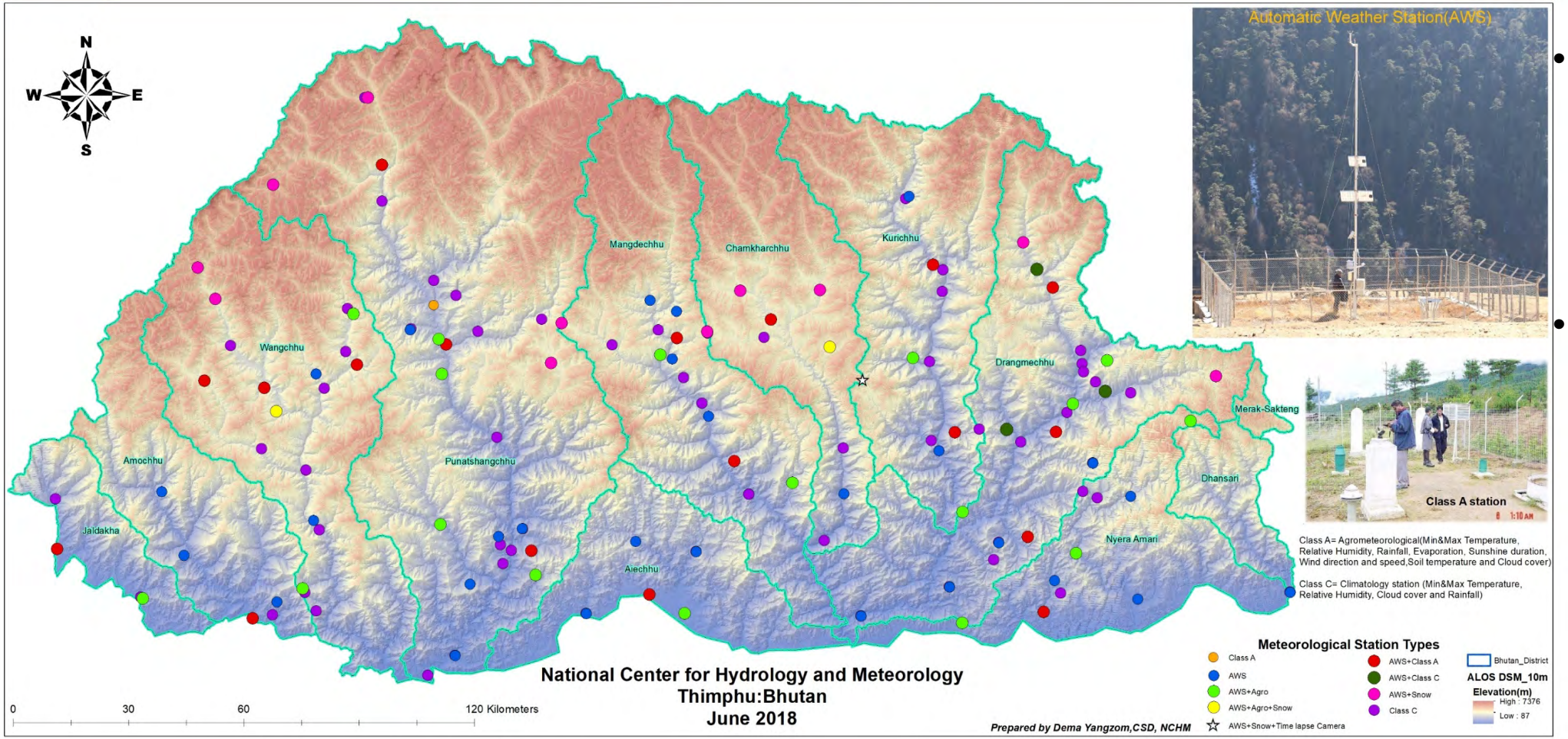
Core Functions

11 Sector specific services (Health, Renewable energy, Transport, Tourism, Engineering stc..)

12 Research and Development Services (R &D)

12 Information systems and ICT

Meteorological Observation Station



Class A= Agrometeorological(Min&Max Temperature, Relative Humidity, Rainfall, Evaporation, Sunshine duration, Wind direction and speed,Soil temperature and Cloud cover)

Class C= Climatology station (Min&Max Temperature, Relative Humidity, Cloud cover and Rainfall)

Bumthang Dzongkha
Chamkhar Class A+AWS
Gyetsa Class C
Ura AWS+Agro+Snow+Class C
Dhur AWS+Snow
Tang AWS+Snow
Yotong La AWS+Snow

Chhukha Dzongkha
Chapcha Class A
Chhukha Class C
Gaedu Class C
GaeduCollege AWS+Agro
Malbase AWS+Class C
Phuentsholing Class A
Tala Class C
Kamji AWS
Tsimasham AWS

Dagana Dzongkha
Dagana Class A
Drujegang Class C
Kerabari Class C
Lhamoizingkha Class +AWS
Sunkosh Class C
Tashithang Class C+AWS

Gasa Dzongkha
Gasakhatey Class A
Laya Class C
Laya AWS+Snow
Damji Class C

Haa Dzongkha
Haa Class A
Dorithasa AWS

Lhuntshe Dzongkha
Tangmachhu Class A
Autsho Class C
Dungkha Class C
Dungkhar AWS
Ladung AWS+Agro
Sumpa Class C
Tangmachhu Class C

Mongar Dzongkha
Korila Class C
Lingmethang Class C
Mongar Class A
Ramjar Class C
Serichhu Class C
Yotong La Class C
Gyelpozhing AWS
Jurmey AWS+Agro
Thrimshing La AWS+Snow+Camera
Yadhi AWS

Paro Dzongkhag
Betikha Class C
Drugyel Class C
Gunitsawa Class C+AWS+Snow
ParoDSC Class A
Cheykha AWS+Snow
Pangbisa AWS+Agro+Snow

Pemagatsel Dzongkhag
Dechenling Class C
Dungmain Class C
Nanglam Class C
Pemagatsel Class A
Yurung AWS+Class C
Dechenling AWS

Punakha Dzongkhag
Lekithang Class A
Samdingkha Class C
Shegana Class C
CNR Lobesa AWS+Agro
Thinleygang AWS
Thinleygang Class C

Samdrupjongkhar Dzongkhag
Gomdar AWS+Agro
Jomotshangkha AWS+Class C
Orong AWS
Phuntshothang AWS
Airong Class C

Samtse Dzongkhag
Samtse NIE AWS+Agro+Class C
Sibsoo Class A
Tendu Class A
Dorokha AWS

Sarpang Dzongkhag
Chuzergang AWS+Agro
Bhur Class A
Jigmecholing AWS+Class C
Mougang AWS
Sarpang AWS+Class C

Trashi Yangtse Dzongkhag
Bumdeling AWS+Class C
Doksum Class C
Trashiyangtse Class A+AWS
Tshenkharla Class C
Tarphel AWS+Snow
Thragom AWS+Agro+Class C

Trongsa Dzongkhag
Bjizam Class C
Chendebji Class C
Kuengarabten Class C
Langthel Class C
Trongsa Class A
Dam Colony AWS
Simphu AWS
Tongtongphey AWS
Tsangkha AWS+Agro

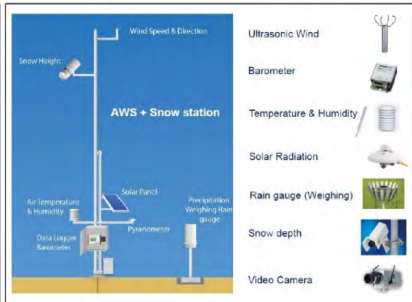
Thimphu Dzongkhag
Bjemina AWS
Begana Class C
Khuzhugchen AWS+Agro
Gidakom Class C
Lingshi AWS+Snow
MoEA Office Class C
Babesa AWS+Class A

Trashigang Dzongkhag
Bartsham Class C
Biding AWS+Class C
Chenary Class C
Deothang Class A
Khaling AWS+Class C
Khangma Class A
Radhi Class C
Sakteng AWS+Snow+Class C
Thrimshing Class C
Wamrong Class C
Yadi Class C
Kangpara AWS
Melphey AWS+Agro
Merak AWS+Snow

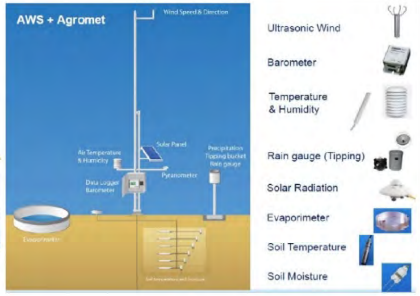
Tsirang Dzongkhag
Damphu Class A
Mendregang Class C
Tsirangtoe Class C
Mendrelgang AWS+Agro
Tsirangtoe AWS

Wangdue Phodrang Dzongkhag
Bajo AWS
Gaselo Class C+AWS+Agro
Pelala AWS+Snow
Phobjikha Class C+AWS+Snow
Kamichhu Class C
Nobding Class C
Pelela Class C
Samtengang Class C
WangdueRnRRC Class A and AWS

Zhemgang Dzongkhag
Buli Class C
Degala Class C
Panbang AWS+Class C
Shingkhar Class C
Tingtibi Class C
Yebilaptsa Class C
Zhemgang AWS+Class A



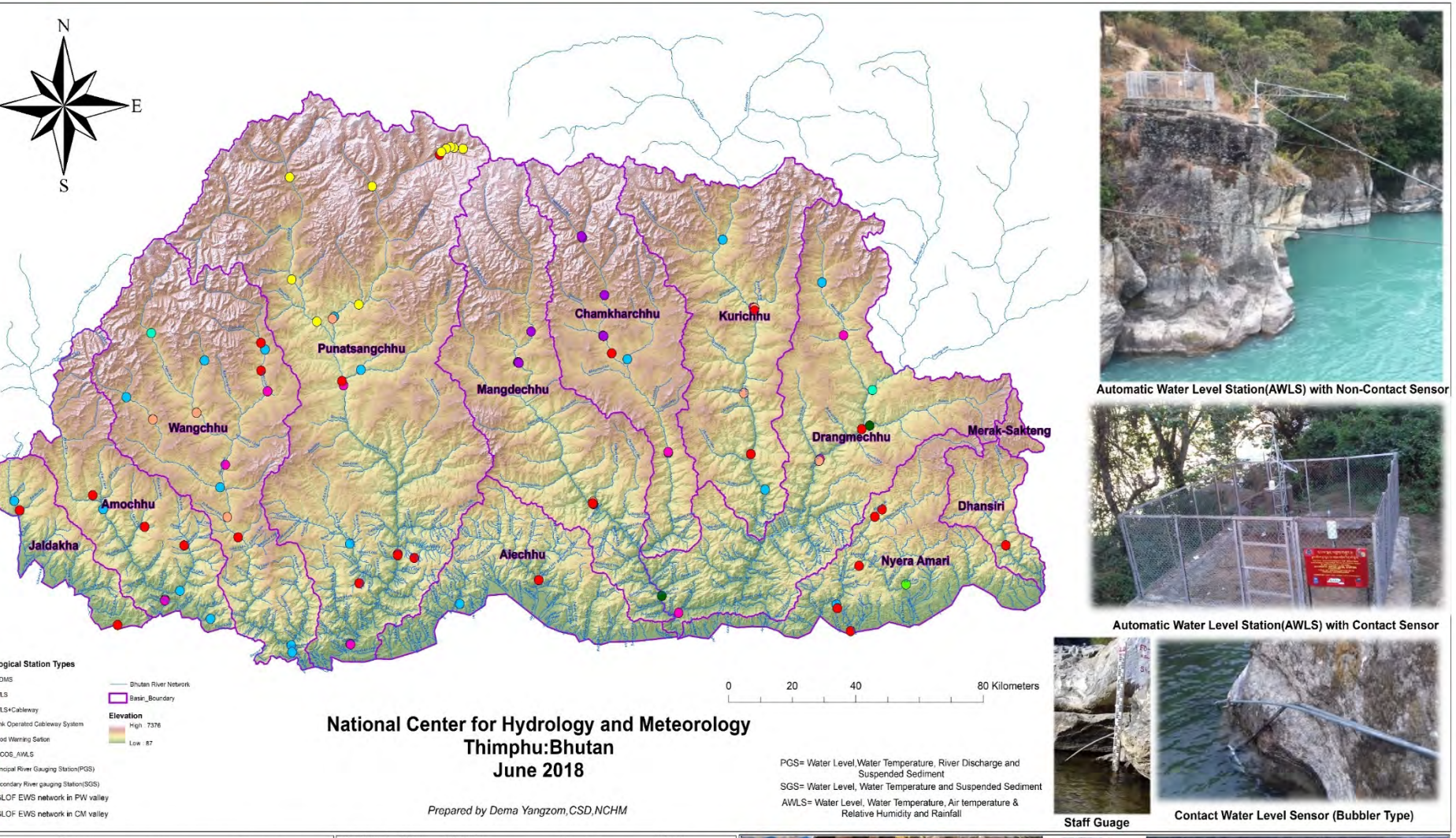
Ultrasonic Wind
Barometer
Temperature & Humidity
Solar Radiation
Rain gauge (Weighing)
Snow depth
Video Camera



Ultrasonic Wind
Barometer
Temperature & Humidity
Rain gauge (Tipping)
Solar Radiation
Evaporimeter
Soil Temperature
Soil Moisture

- *155 Climate Station*
  - *20 Class A*
  - *73 Class C*
  - *62 AWS*
- *20 Cryosphere Observation Stations*
  - *2 Long term Glacier Mass balance site*
  - *4 Automatic Snow Station*
  - *14 Manual Station*

Hydrological Observation Station



National Center for Hydrology and Meteorology
Thimphu:Bhutan
June 2018

Prepared by Dema Yangzom,CSD,NCHM

PGS= Water Level,Water Temperature, River Discharge and Suspended Sediment
SGS= Water Level, Water Temperature and Suspended Sediment
AWLS= Water Level, Water Temperature, Air temperature & Relative Humidity and Rainfall

Automatic Water Level Station(AWLS) with Non-Contact Sensor

Automatic Water Level Station(AWLS) with Contact Sensor

Staff Guage

Contact Water Level Sensor (Bubbler Type)

Dagana
Piping AWLS
Dagachhu AWLS
Kenabari AWLS
Sunkosh FWS
Dagapela FWS
Lhamoizingkha PGS

Gasa
Thanza FWS
Luggy Tsho AWLS
Thorthormi AWLS
Rapstreng AWLS
Bay Tsho AWLS
Tarina AWLS+AWS
Dangsa AWLS+AWS
Taktsemakhang AWLS+AWS

Haa
Sangbaykha AWLS
Damthang AWLS
Useu ARDMS
Hachhu SGS
Sangbaykha FWS

Lhuntse
Autsho AWLS+SGS
Khoma AWLS+SGS
Dungkhar AWLS
Sumpa PGS
Sumpa FWS

Monggar
Gyelposhing AWLS
Sherichhu AWLS+SGS
Kurizampa PGS
Kurizampa FWS
Thrimshing FWS

Paro
Bondey Cableway+SGS
Doteng AWLS
Naja AWLS
Gunitsawa AWLS

Punakha
Samdingkha AWLS+SGS
Yebesa PGS
Yebesa AWLS
Tashithang AWLS

Samdrup Jongkhar
Bangtar Cableway
Dewri AWLS
Deothang FWS
Zamtari FWS
S/Jongkhar FWS
Tokorong FWS

Samtse
Doyagang AWLS+PGS
Jaldhaka-Thika AWLS
Tendru FWS
Gomtu FWS
Pungtha FWS

Sarpang
Sarpangchhu AWLS
Shershong FWS

Thimphu
Lungtenphu ARDMS
Lungtenphu Cableway
Khuzhugchen AWLS
Begana FWS
Thimphu FWS
Hejo AWLS

Trashi Yangtse
Tarfel AWLS
Riju AWLS+Cableway
Doksum AWLS
Muktirap PGS

Trashigang
Uzorong PGS
Chazam FWS
Pangzam FWS

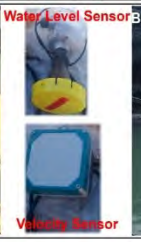
Trongsa
Bjizam AWLS+PGS
Mangdechhu FWS
Jongthang AWLS

Wangdue Phodrang
Chuzomsa AWLS
WangdiRapids PGS
Wangdue FWS

Zhemgang
Tingtibi AWLS+PGS
Bemethang AWLS+PGS
Chamkhar-Mangde AWLS+Cableway
Panbang PGS
Dakpaichhu SGS

Tsirang
Turitar PGS
Tsirang FWS

PGS= Principal River Gauging Station
SGS= Secondary River Gauging Station



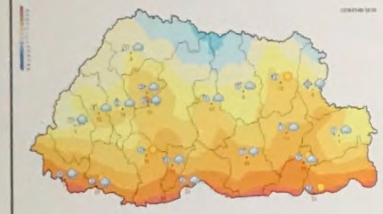
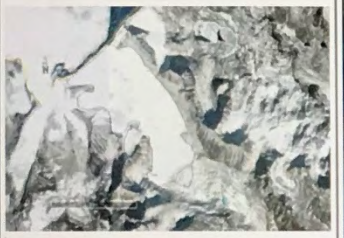
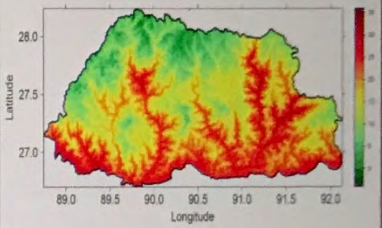
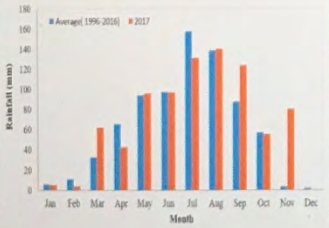
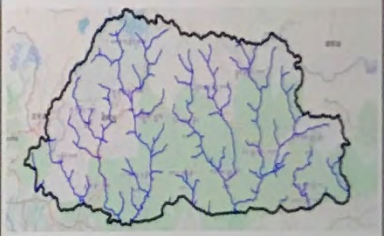
- ***59 Hydrological Observation Station***
  - ***16 Principal Station (Cableway)***
  - ***9 Secondary Station***
  - ***34 AWLS***

- ***16 Sediment Sampling Stations***

Current Hydro-met Services and Products

Our Products and Services Quick View

Our Products and Services Quick View

Weather Services 	CryosphereServices 	Satellite Images 	Aviation Services 	Climate Services 
Agro-met services 	Hydromet Data 		Hydromet Network 	Hydrology Services 

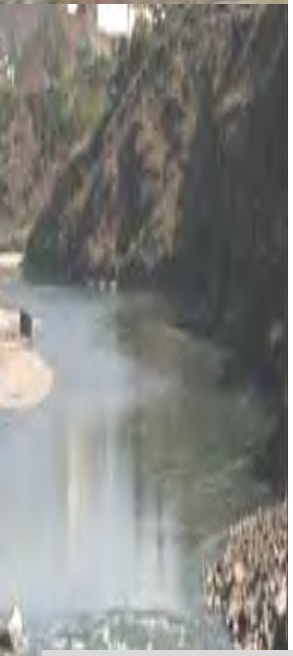
WEATHER FORECASTING

72 Hours Weather forecasting

3 DAYS FORECAST | JUL 30 | JUL 31 | AUG 01

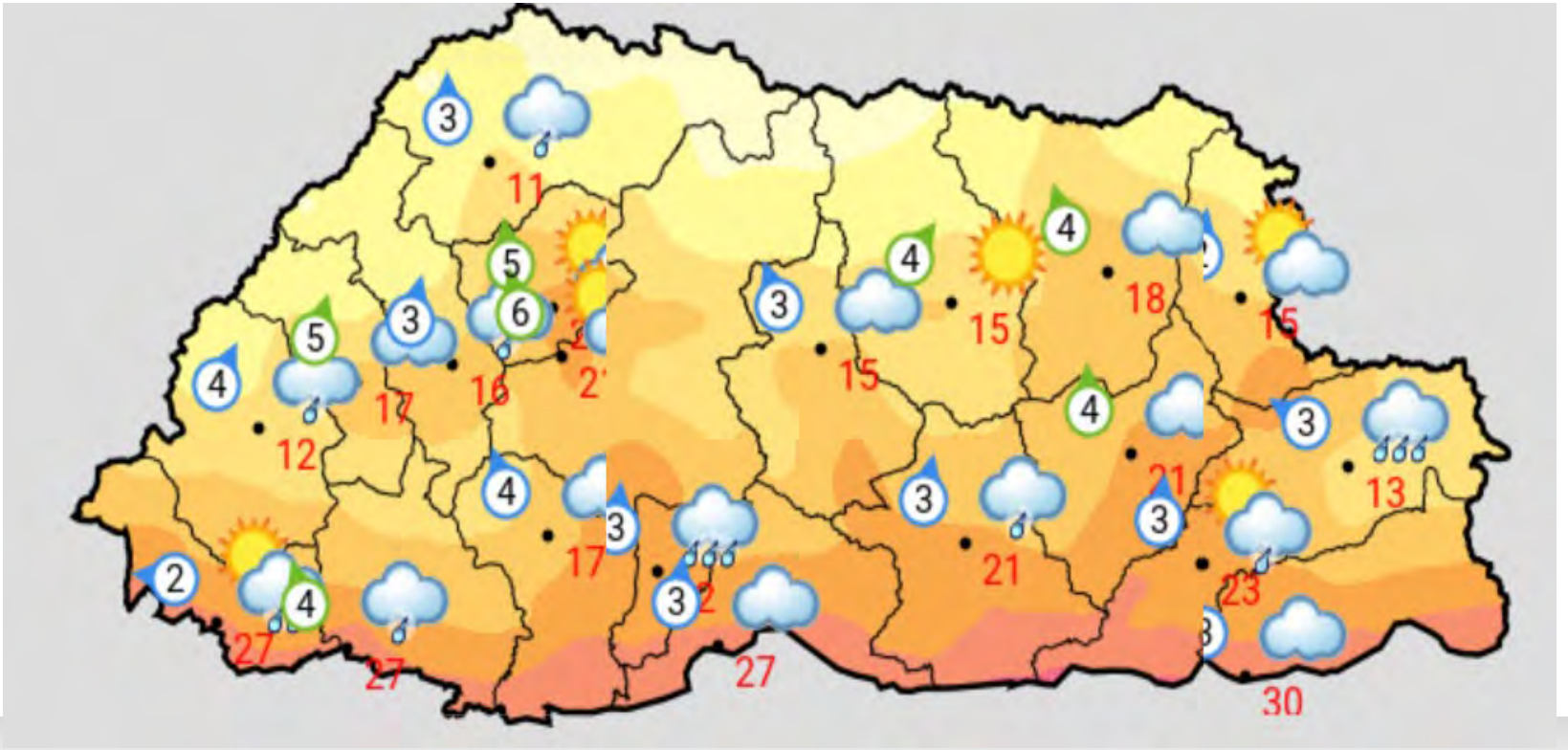
Max: 29 °C Min: 15 °C	Max: 28 °C Min: 15 °C	Max: 25 °C Min: 14 °C
Gasa	**Bumthang**	**Trongsa**
Max: 23 °C Min: 13 °C	Max: 25 °C Min: 15 °C	Max: 25 °C Min: 16 °C
Tsirang	**Wangdue**	**Punakha**
Max: 27 °C Min: 17 °C	Max: 31 °C Min: 21 °C	Max: 32 °C Min: 22 °C
Dagana	**Zhemgang**	**Chhukha**
Max: 27 °C	Max: 25 °C	Max: 26 °C

Weather forecasting system

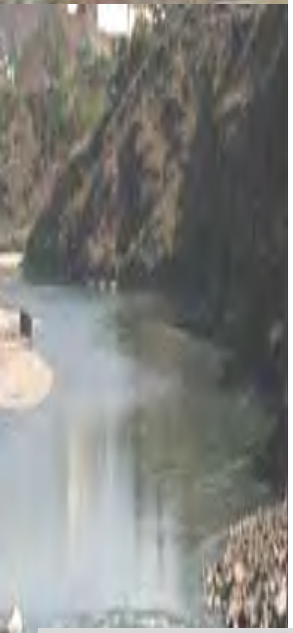


WEATHER FORECASTING

Daily Weather forecasting

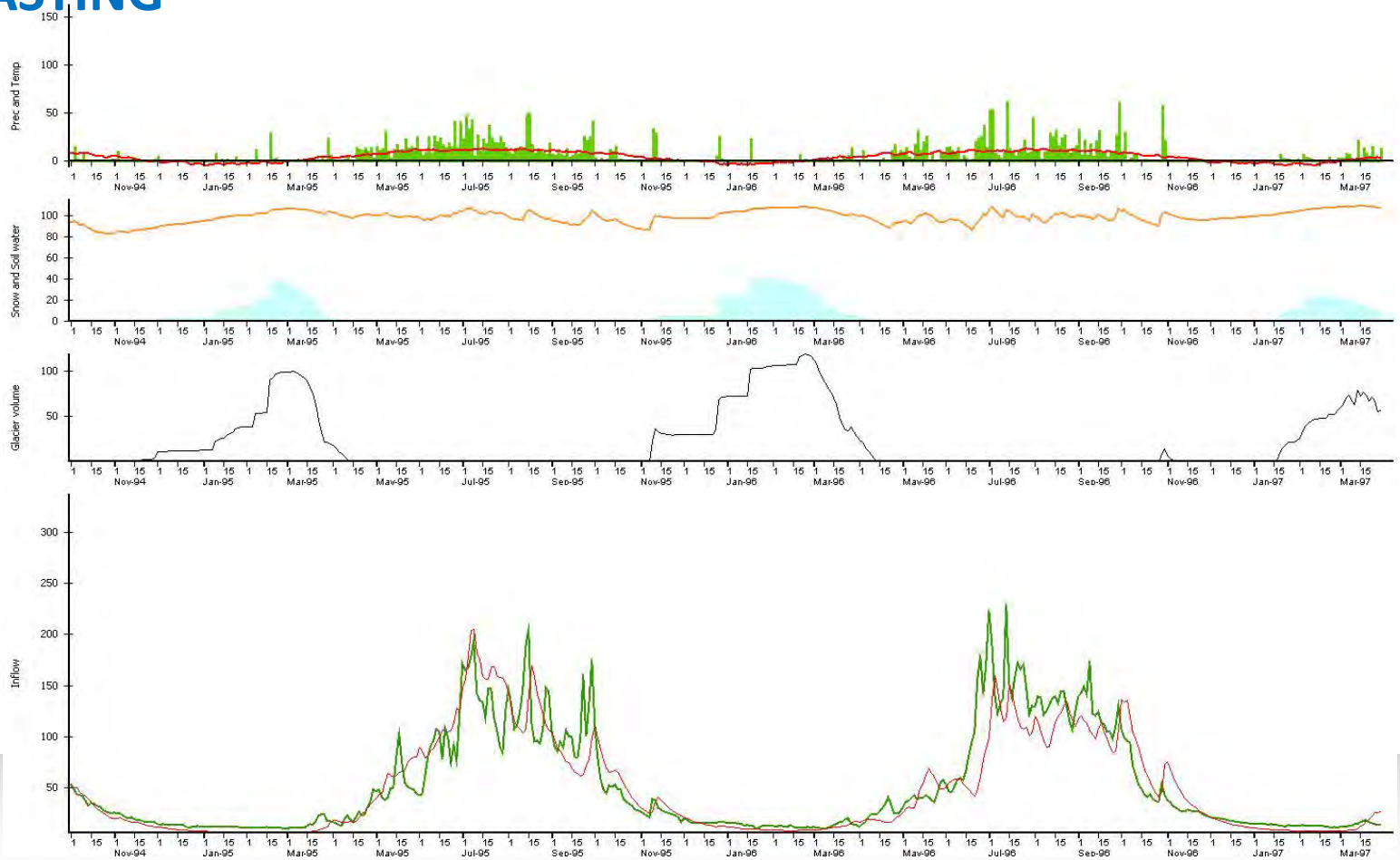


Daily Weather forecast



FLOW & FLOOD FORECASTING

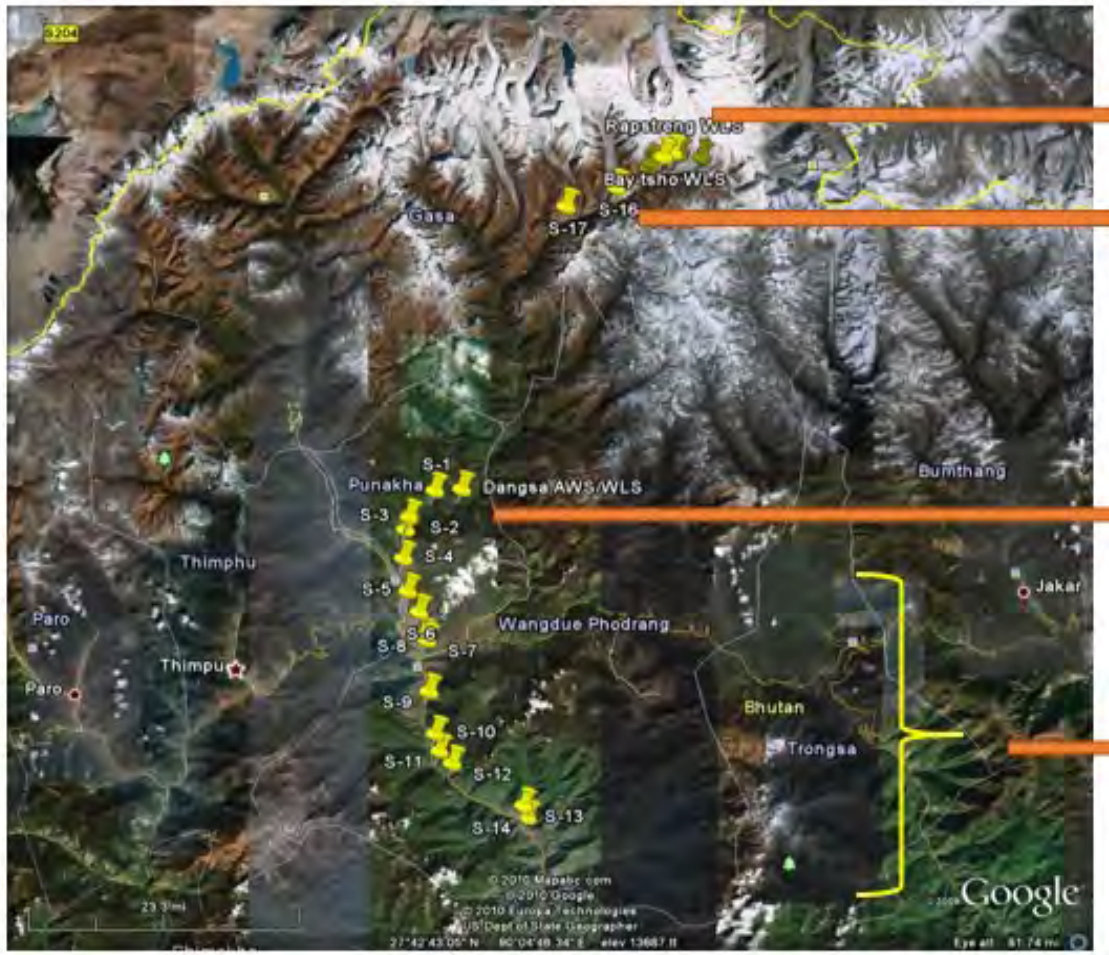
Flow and Flood forecasting system piloted



Flow forecast using HBV

Early Warning Systems (GLOF and Rainstorm)

Early Warning systems in three Basins



4 Lakes in Lunana

3 siren stations in Lunana village

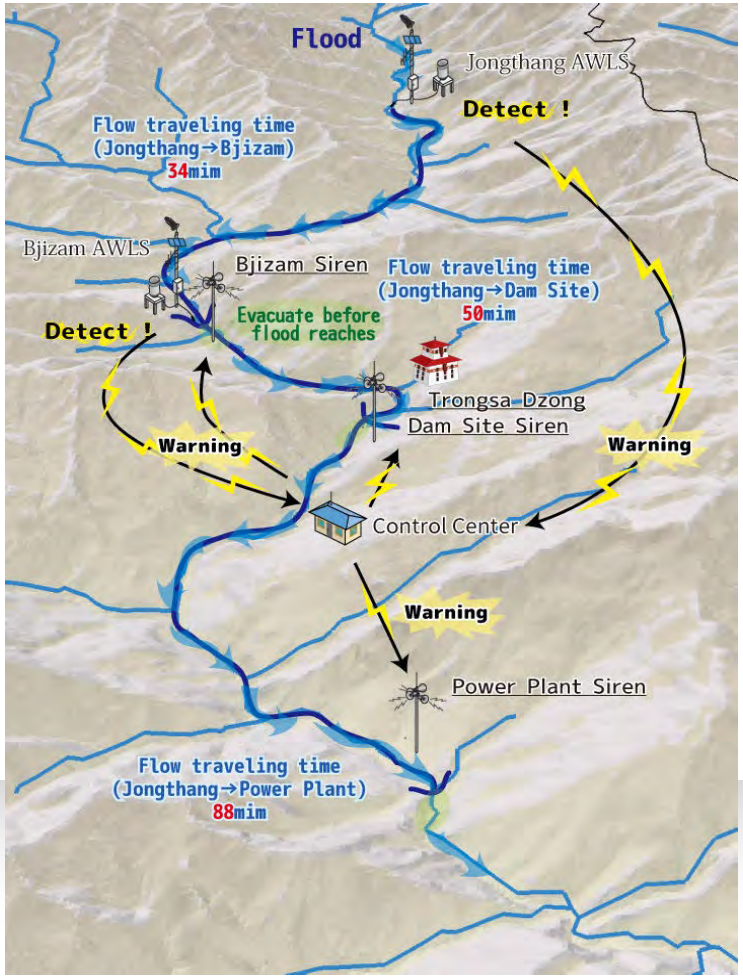
2 AWS/AWLS in Dangsa and Thanza

14 Siren stations in Punkaha Wangdue valley

GLOF Early Warning system in Punatshangchu Basin, Western Bhutan

Early Warning Systems (GLOF and Rainstorm)

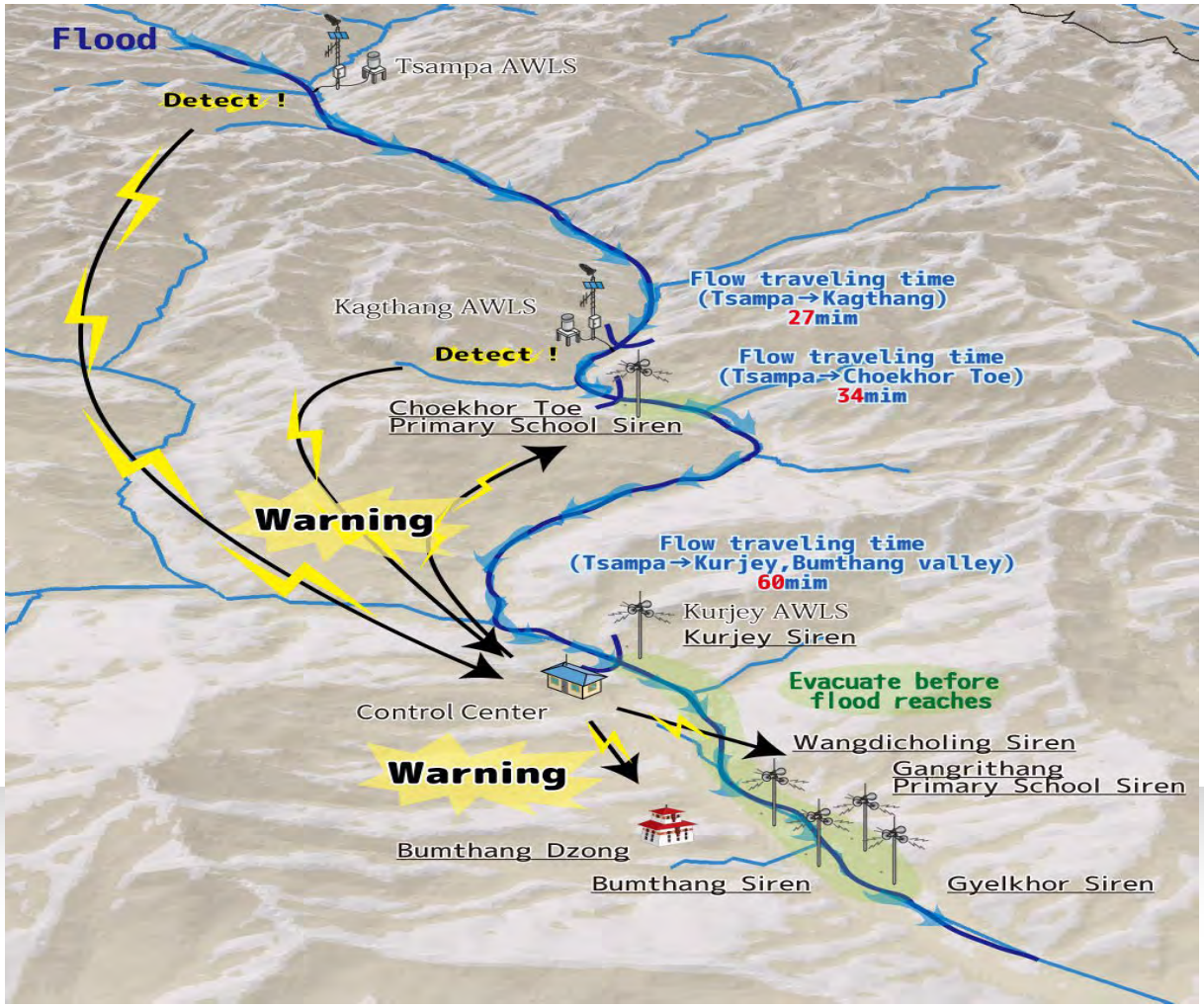
Early Warning systems in three Basins



GLOF and Rainstrom Early Warning system in Mangdechhu Basin, Central Bhutan

Early Warning Systems (GLOF and Rainstorm)

Early Warning systems in three Basins

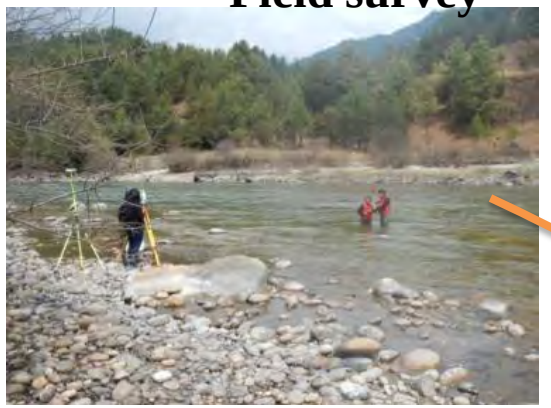


GLOF and Rainstrom Early Warning system in Chamkhar chhu Basin, Bumthang, Central Bhutan

Flood Hazard and Risk Mapping

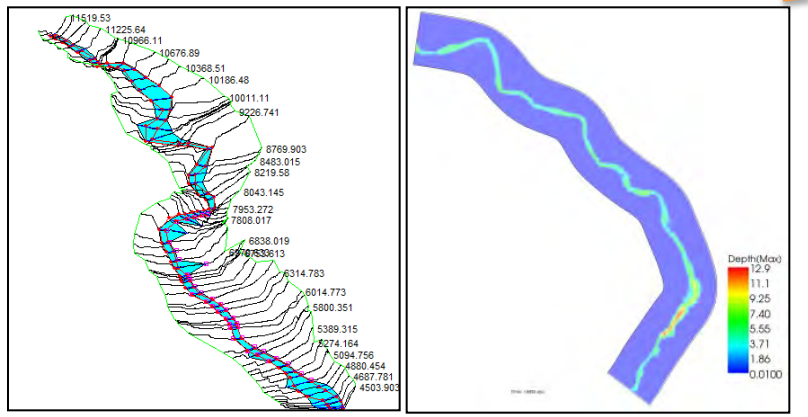
Flood Hazard Map

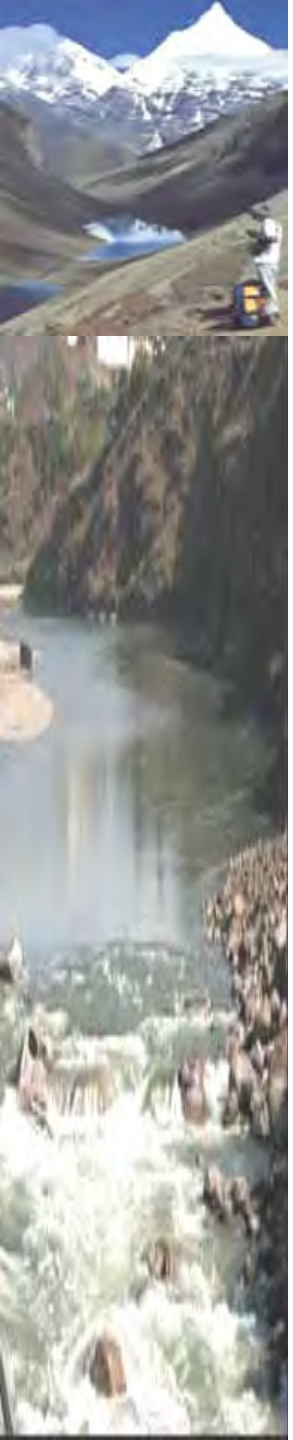
Field survey



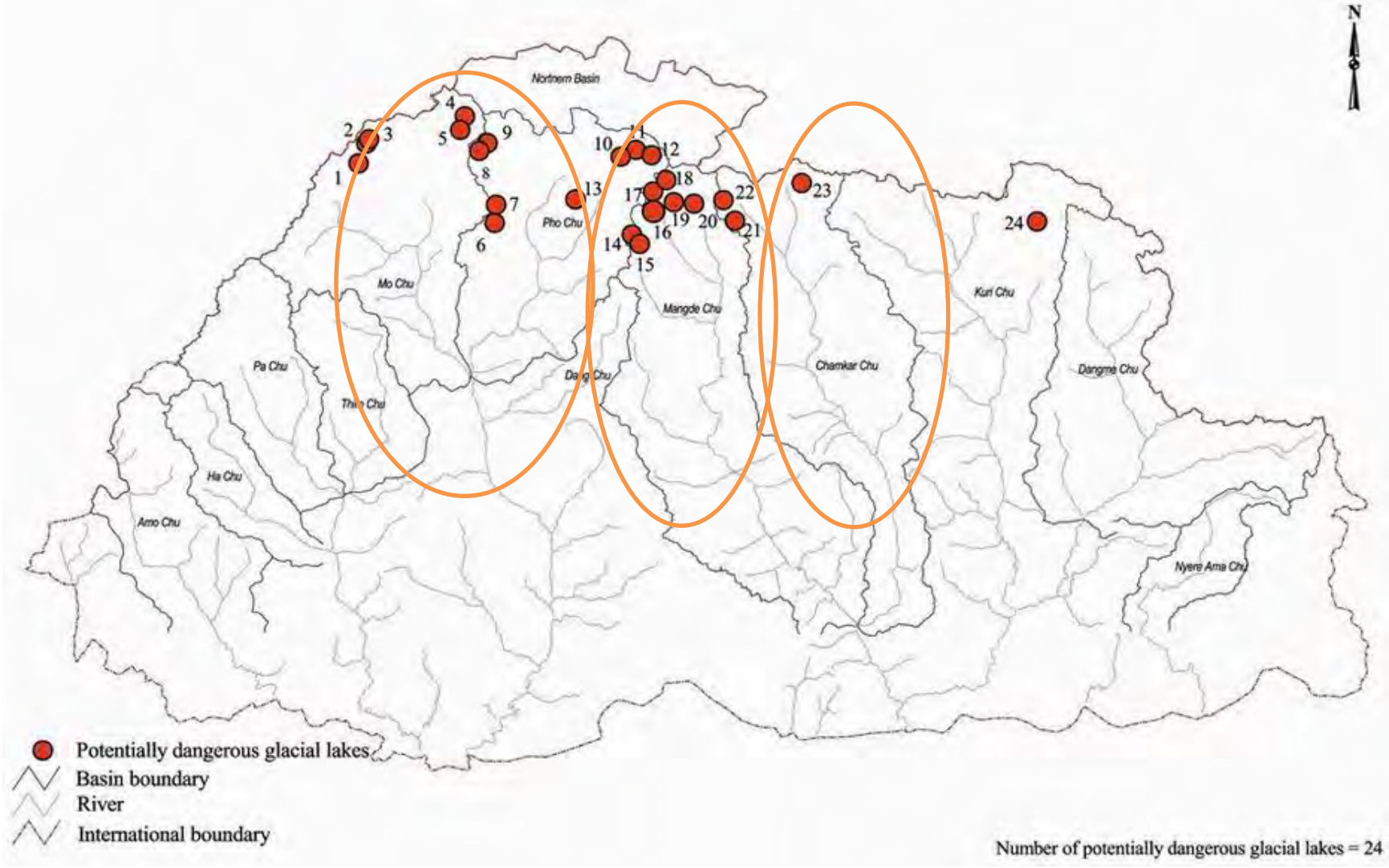
Runoff/flood analysis

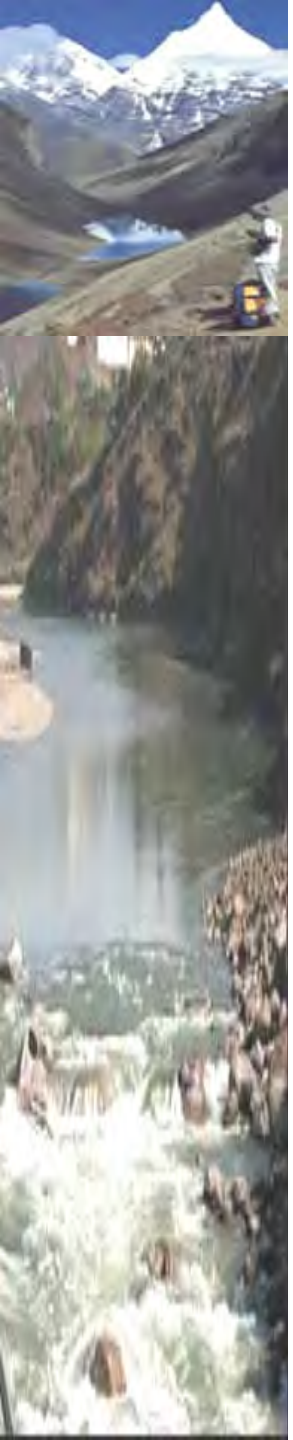
Modeling & Analysis

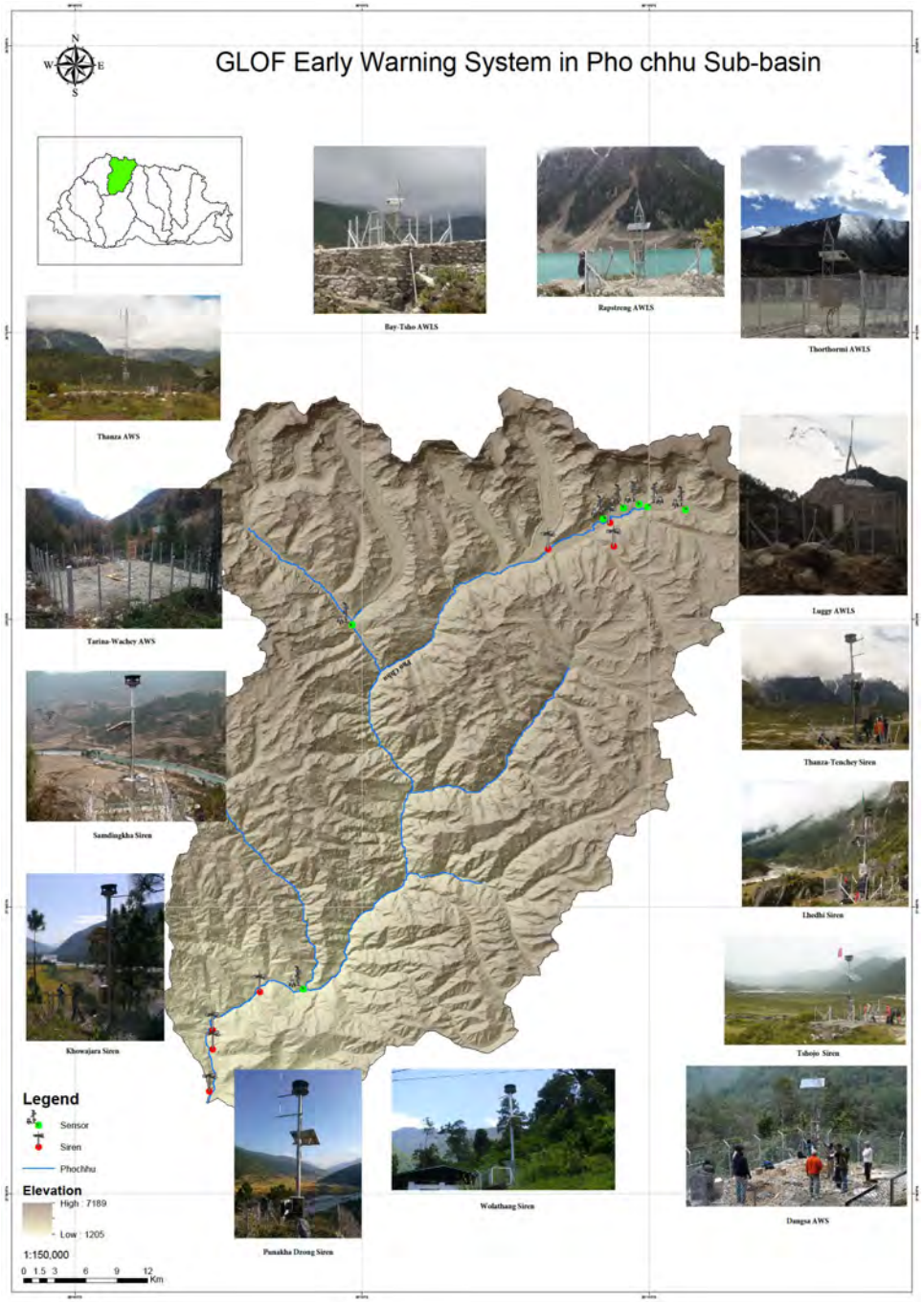


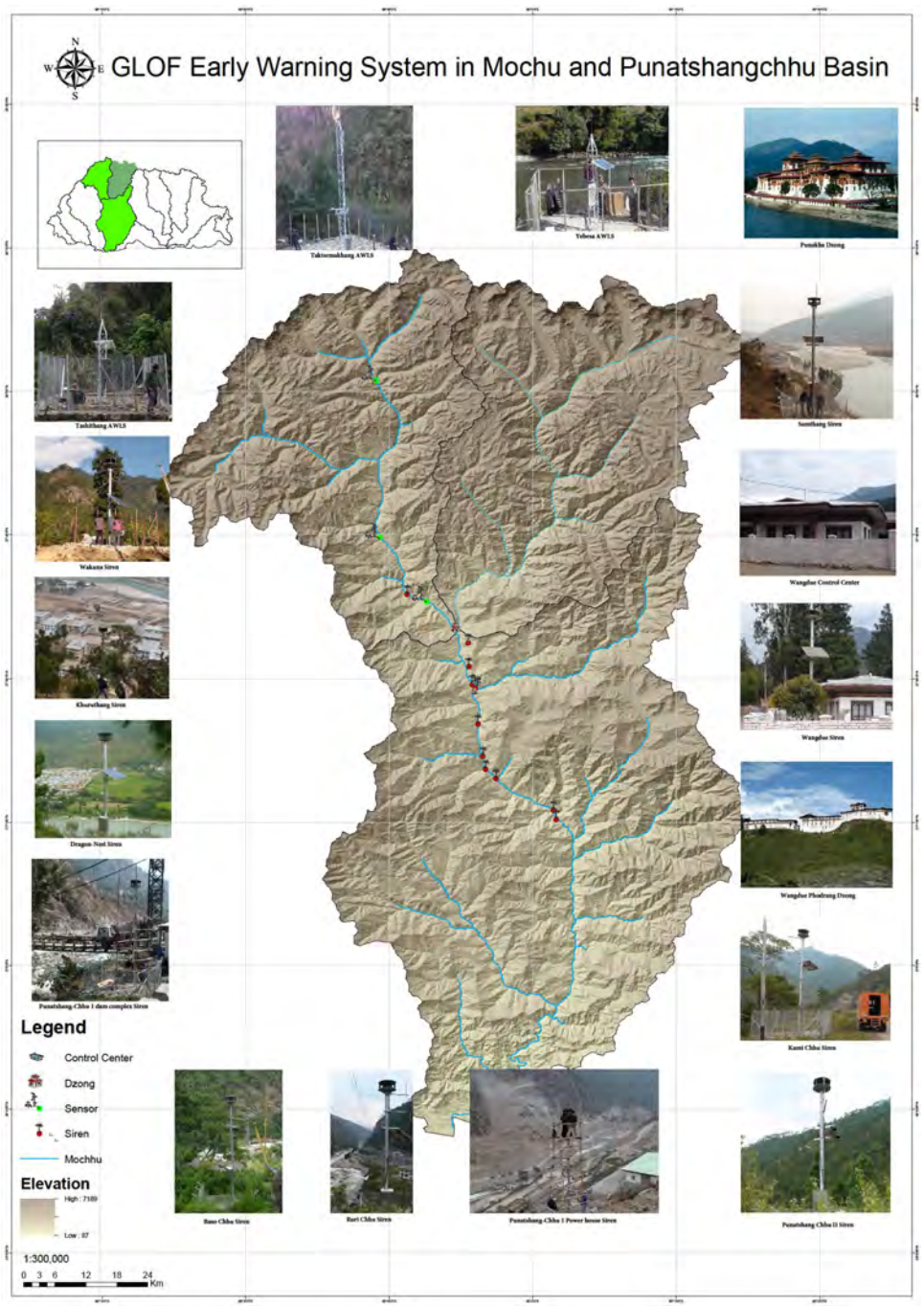


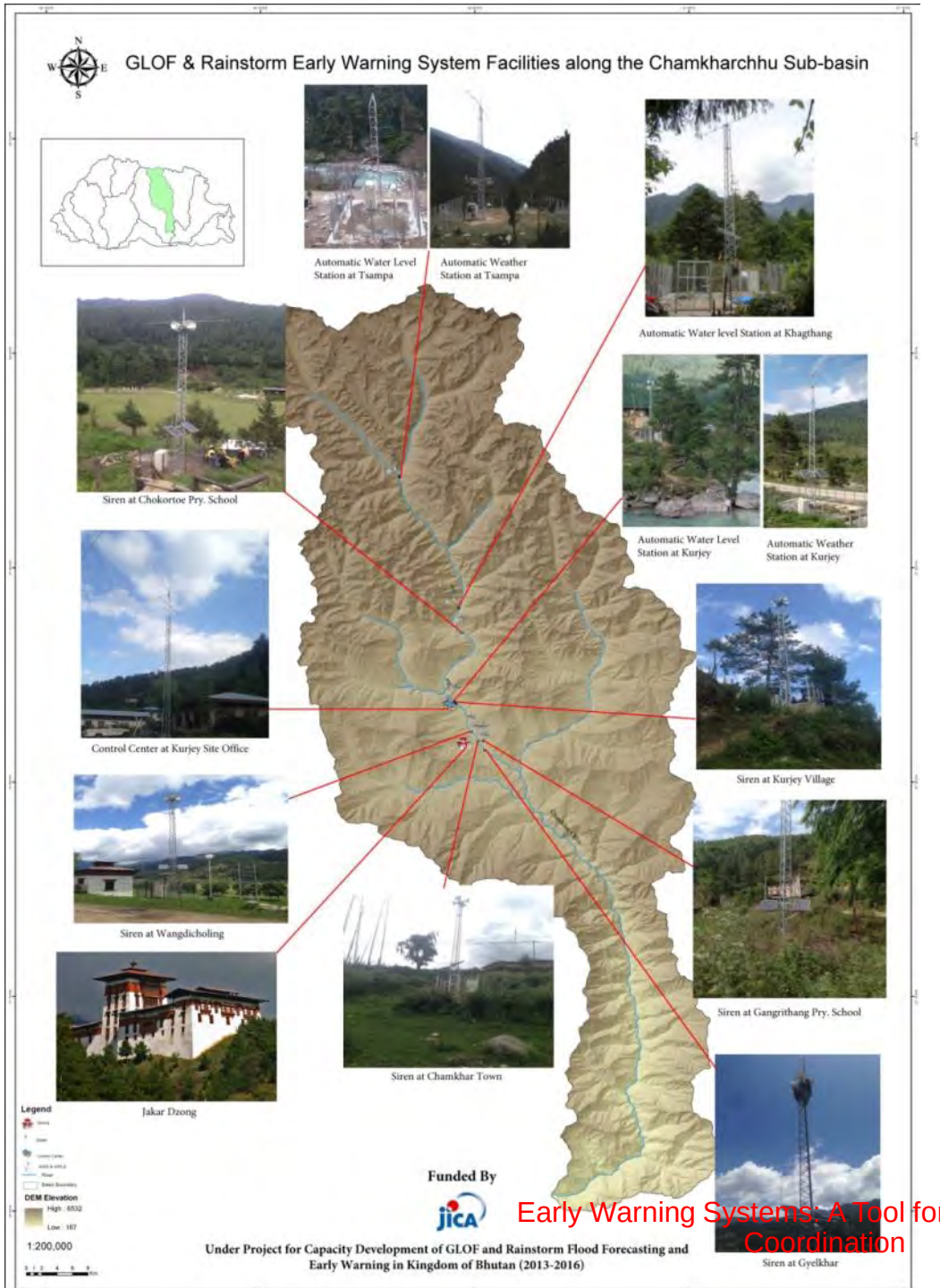
Potentially Dangerous Glacial Lakes






GLOF Early Warning System in Pho chhu Sub-basin
Bay-Taba AWLS
Rapstreng AWLS
Thorthormi AWLS
Thanza AWS
Tarina-Wachey AWS
Luggy AWLS
Thanza-Tenchey Siren
Samdingkha Siren
Lhedhi Siren
Khowajara Siren
Tshojo Siren
Punakha Dzong Siren
Wolathang Siren
Dangsa AWS
Legend
Sensor
Siren
Phochhu
Elevation
High : 7189
Low : 1205
1:150,000
0 1.5 3 6 9 12
Km

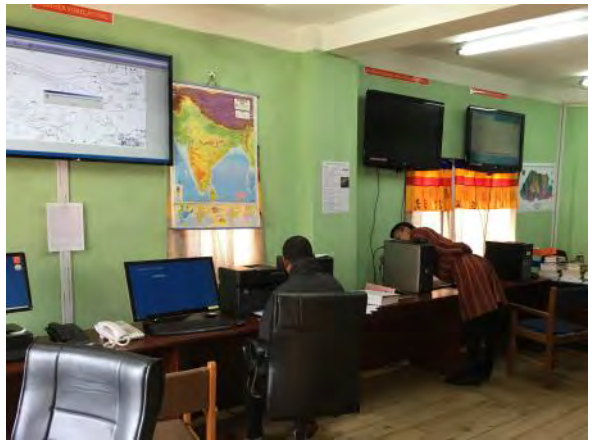

GLOF Early Warning System in Mochu and Punatshangchhu Basin
Taktsemkhang AWLS
Tshesu AWLS
Punakha Dzong
Tashithang AWLS
Sumthang Siren
Wakana Siren
Wangdue Control Center
Khuruthang Siren
Wangdue Siren
Dragon Nest Siren
Wangdue Phodrang Dzong
Punatshang Chhu 1 dam complex Siren
Kazmi Chhu Siren
Bano Chhu Siren
Bori Chhu Siren
Punatshang-Chhu 1 Power house Siren
Punatshang Chhu II Siren
Legend
Control Center
Dzong
Sensor
Siren
Mochhu
Elevation
High : 7189
Low : 87
1:300,000
0 3 6 12 18 24
Km



Early Warning Systems: A Tool fo
Coordination

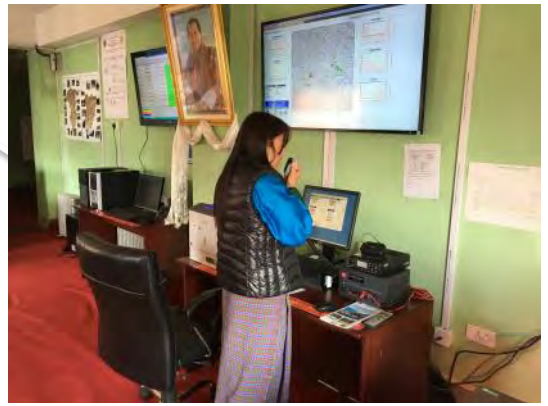
24/7 National Weather and Flood Warning Center (NWFWC), NCHM

Satellite image receiver
(HimawariCast)

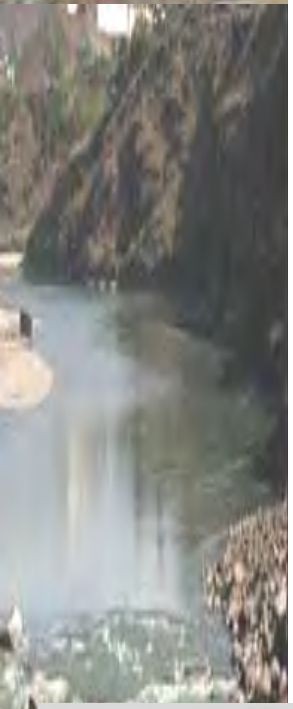


2nd floor:
Weather forecasting room/
GTS/MSS Operation room

Ground floor:
Day-care center

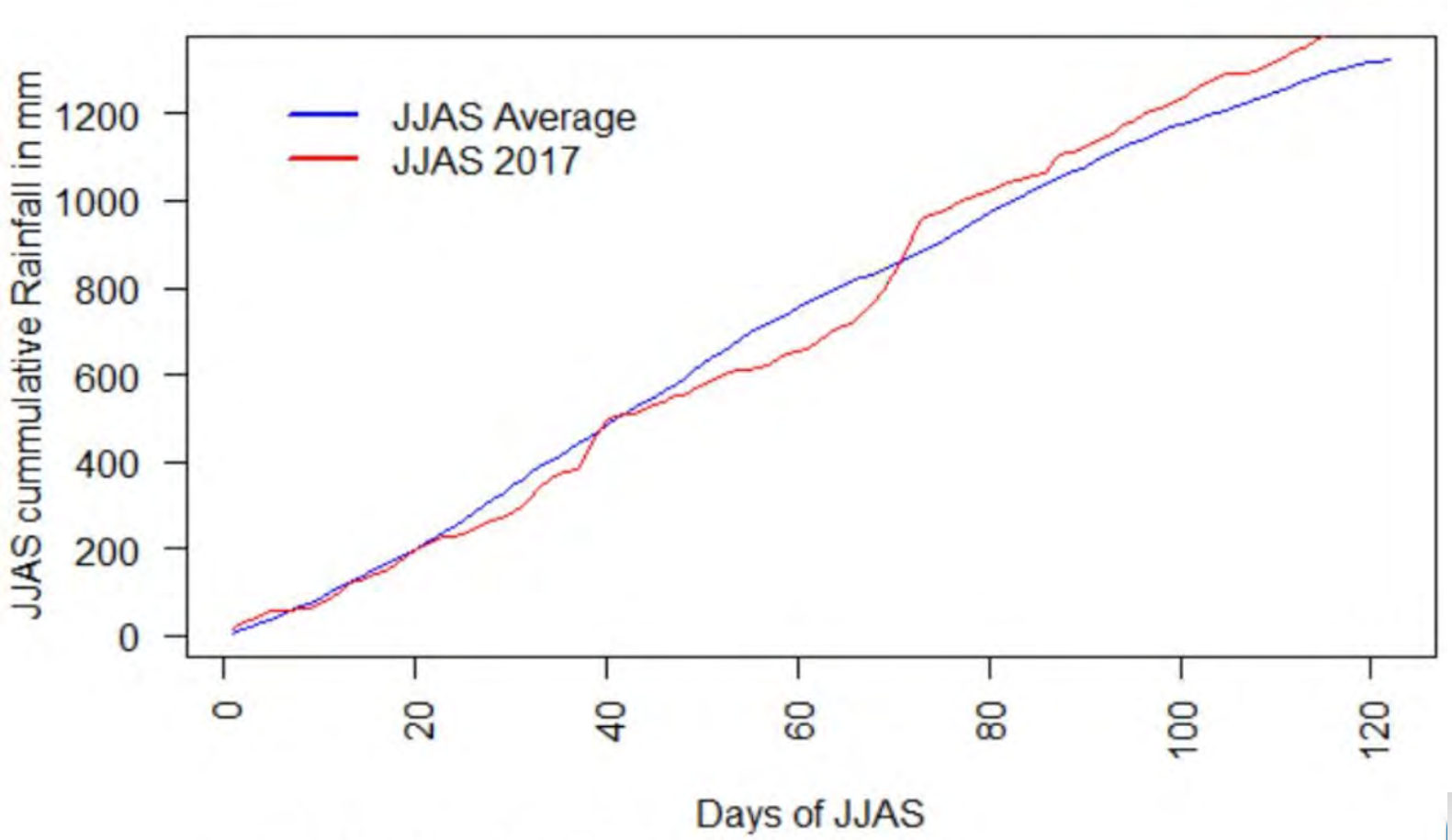


1st floor:
flood monitoring & warning room,
emergency meeting room



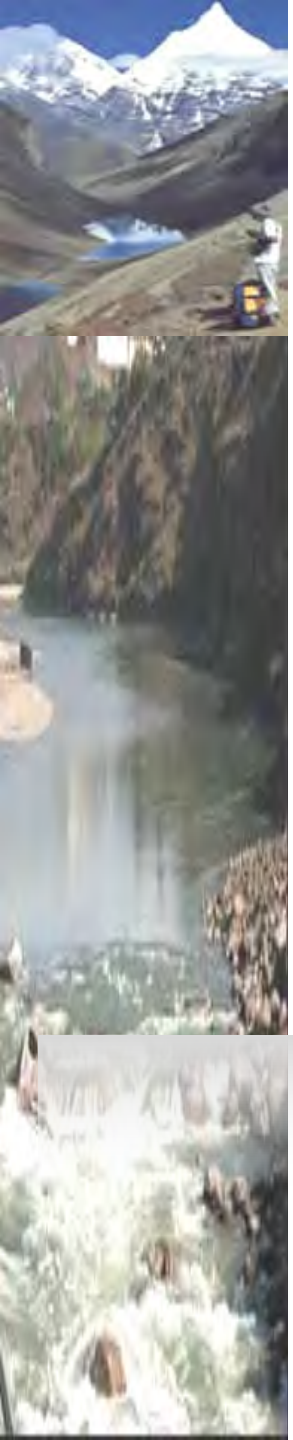
Climate Services

Improved climate service



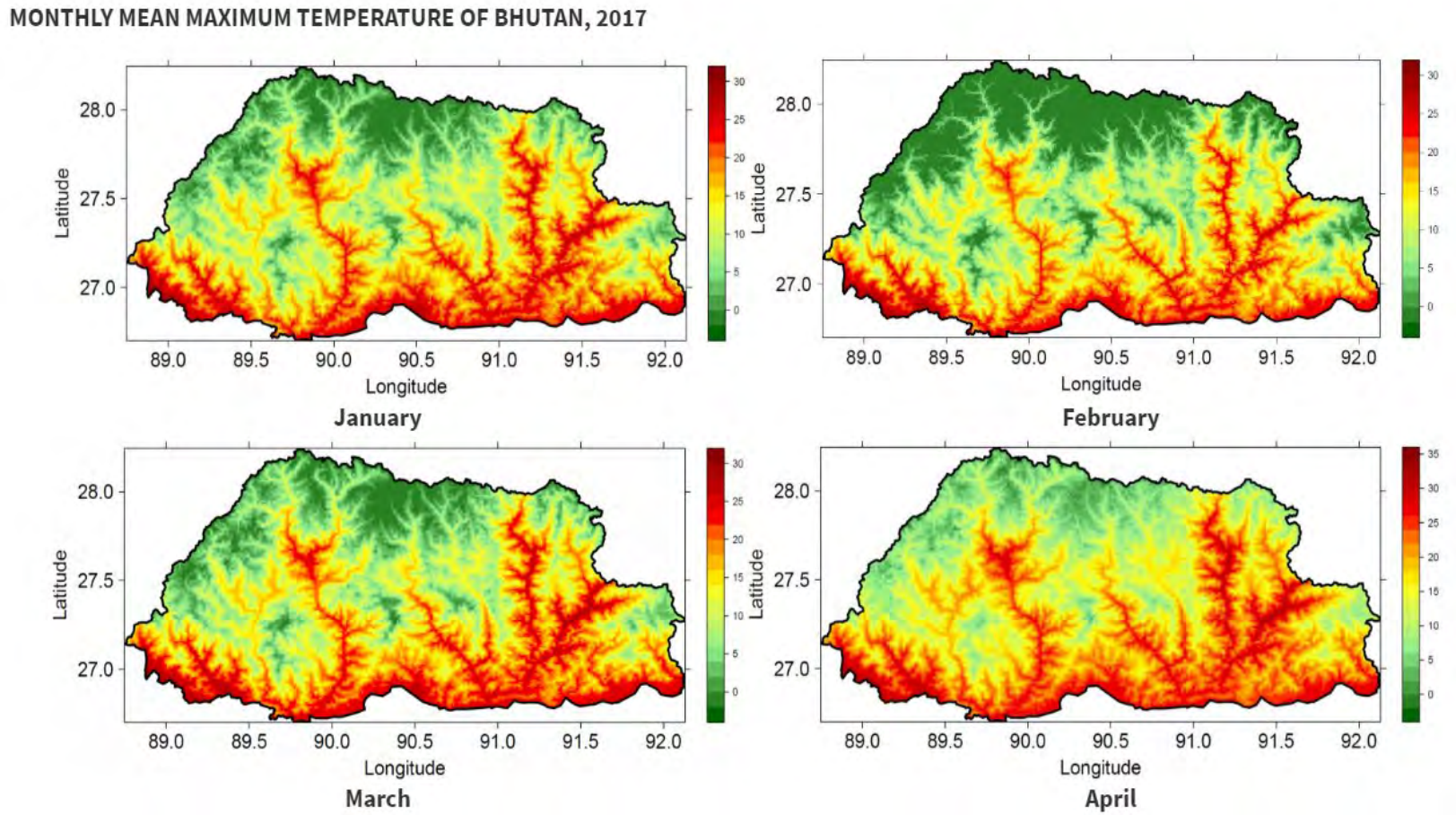
June July August September(JJAS) cumulative rainfall (Area average)

Monsoon monitoring

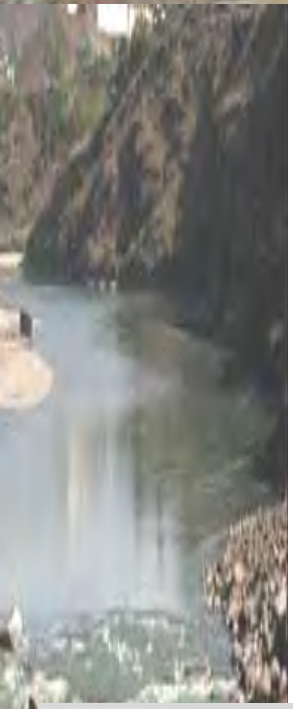


Improved Climate Services

climate services

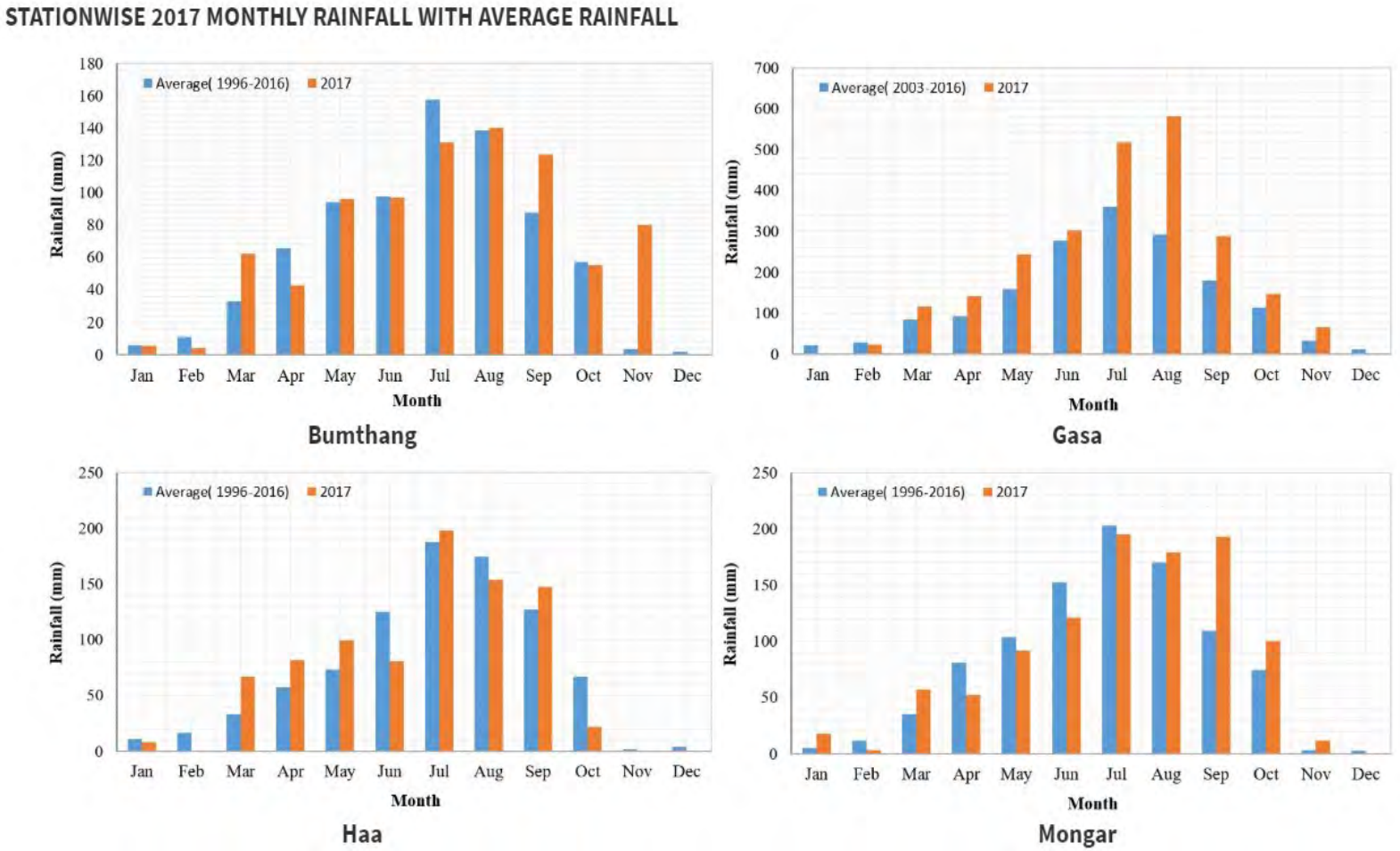


Temperature monitoring

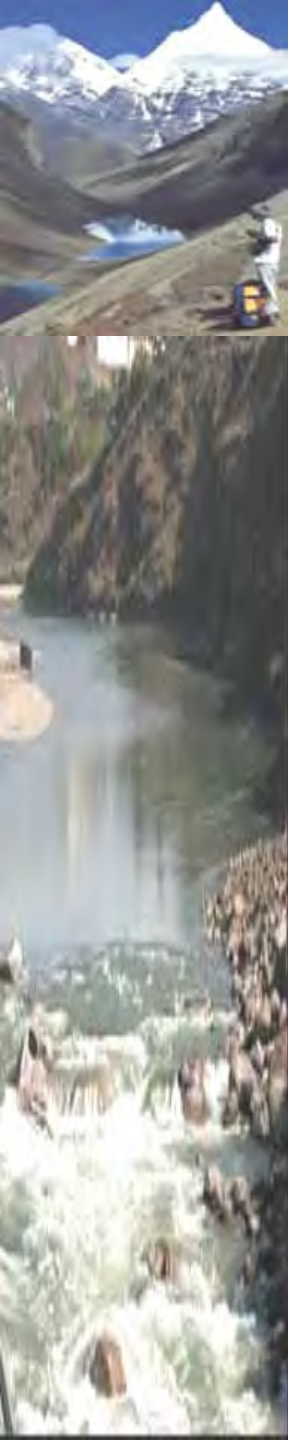


Improved Climate Services

climate services



Rainfall monitoring



Glacier monitoring

- ✓ Mass Balance (surface lowering, mass gain or mass loss)
- ✓ Status of Glacier snout (Retreating or Advancing)
- ✓ Status of Glacial lakes (Potentially Dangerous Glacial Lakes)
  - Lake Bathymetry
  - GLOF Risk Assessment

- ✓ **Water Resource Assessment**
  - Contribution of melt water to surface runoff

  - Snow
    - Snow cover
    - Snow Water equivalent

Cryosphere Monitoring Program

Identified Benchmark Glaciers

Thana Glacier

Type: Clean type
Area: 3.0 km2
Location: **Coordinates:**
Latitude: 28° 1'17.90"N
Longitude: 90°36'39.16"E
Elevation: 5340m a.s.l
Maximum Elevation: 5600m a.s.l
Minimum Elevation: 5250m a.s.l
Basin: Headwater of Chamkhar Chhu, Manas Basin
Initial Survey: 2013
Status of Study: Ongoing

Gangjula Glacier

Type: Clean type
Area: 0.3 km2
Location: **Coordinates:**
Latitude: 27°56'24.17"N
Longitude: 89°56'53.70"E
Elevation: 5145m a.s.l
Maximum Elevation: 5200m a.s.l
Minimum Elevation: 4900m a.s.l
Basin: Headwater of Pho Chhu, Punatsang Chhu basin.
Initial Survey: 2004
Status of Study: Ongoing

Hazards and Vulnerability in Bhutan

a. Floods
   - GLOF
   - Flash Floods
   - LDOF

b. Windstorm/Cyclones

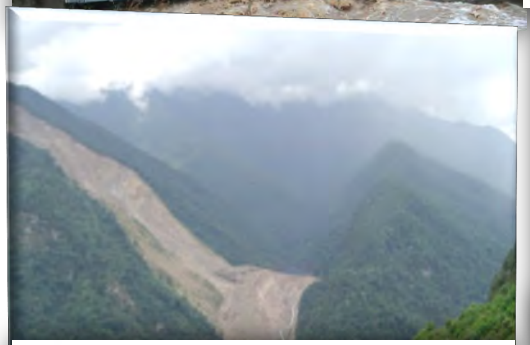
c. Landsides

d. Forest Fires

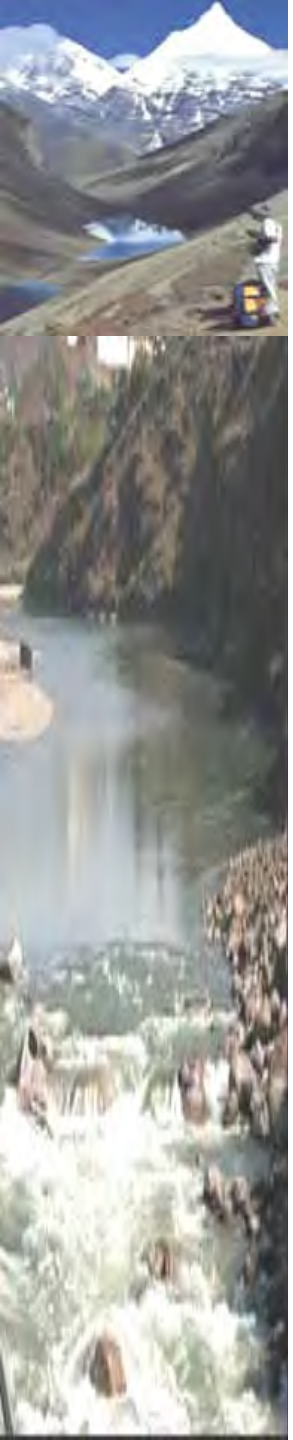
e. Earthquake

f. Epidemics, pests and diseases:

Punakha Dzong three days after the disaster of 1994. Also shown is the confluence of the Phochu and the Mochu below the Dzong and scars of the back flow water after it had joined the Mochu and dammed the flow above the Dzong. (Phuntso Norbu 1994)

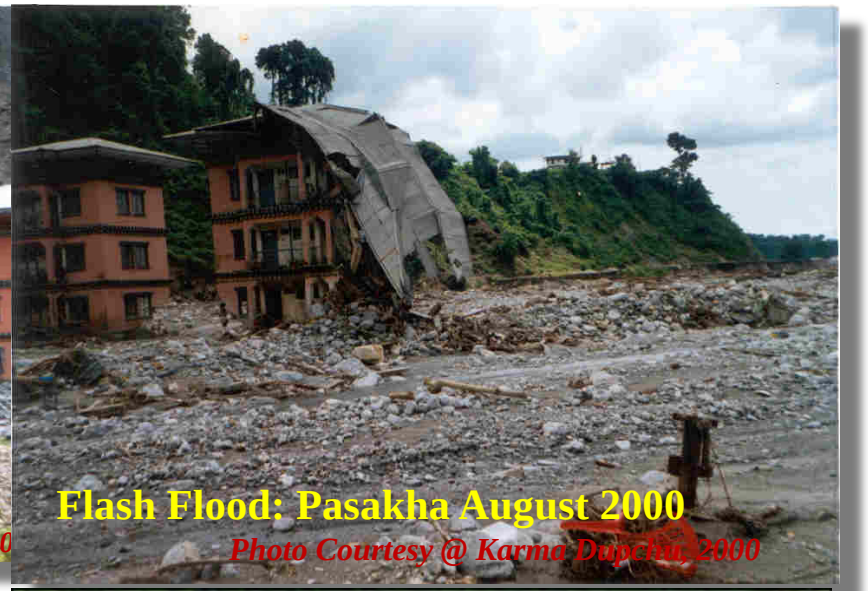


Flash Flood Impacts



Flash Flood: Pasakha August 2000

Photo Courtesy @ Karma Dupchu, 200



Flash Flood: Pasakha August 2000

Photo Courtesy @ Karma Dupchu, 2000

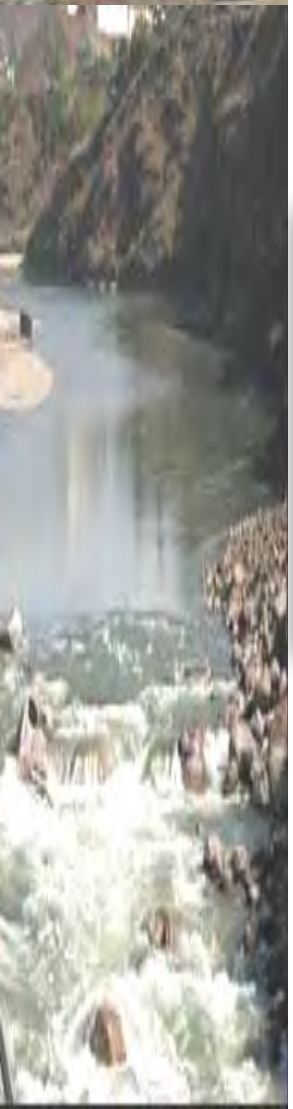
Flash Flood: Intake of Ranjung Power Plant destroyed 2004

Photo Courtesy @ Karma Dupchu, 2004

2004 Flash Flood Eastern Bhutan

Photo Courtesy @ Kuensel

Risks and Vulnerability

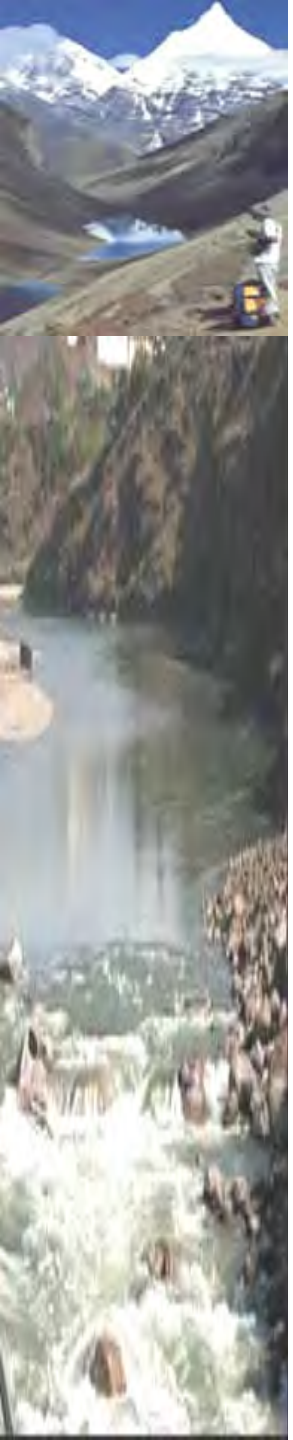


Monuments

Bumthang Domestic Airport

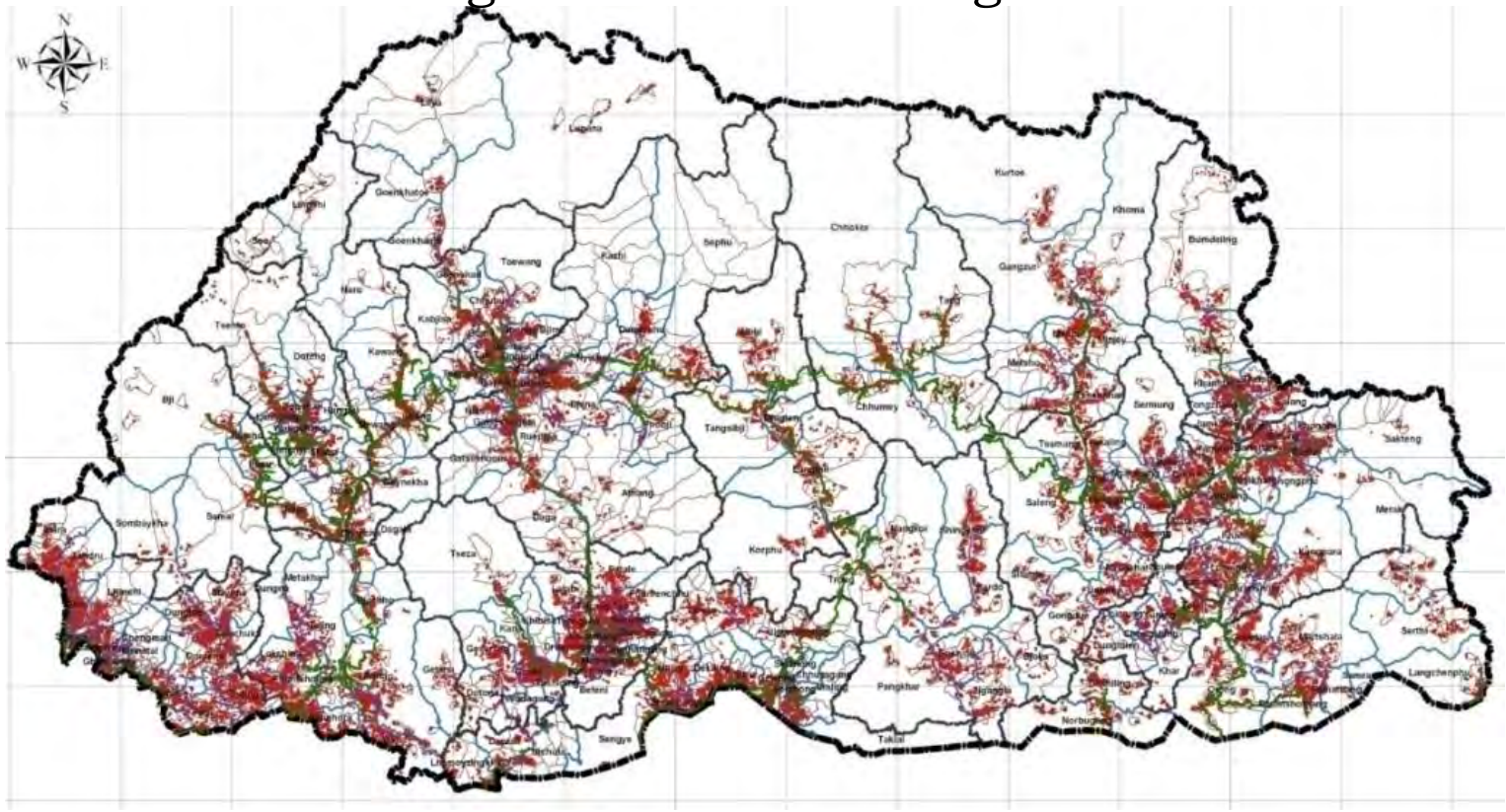
Agriculture land

Hydropower Plants

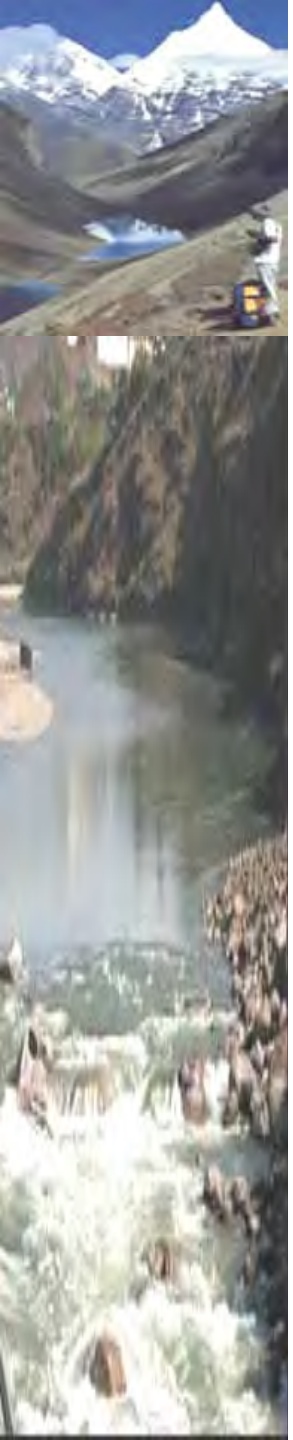


Flooding Risks

- Flooding is a recurrent phenomenon, especially during the monsoon season.
- Infrastructure (urban areas, hydropower plants, roads, airports, etc) and most of the settlements, fertile agricultural land are located along the valleys.
- Over 70 percent of the settlements are located along the main drainage basins and are therefore at high risk from flooding.

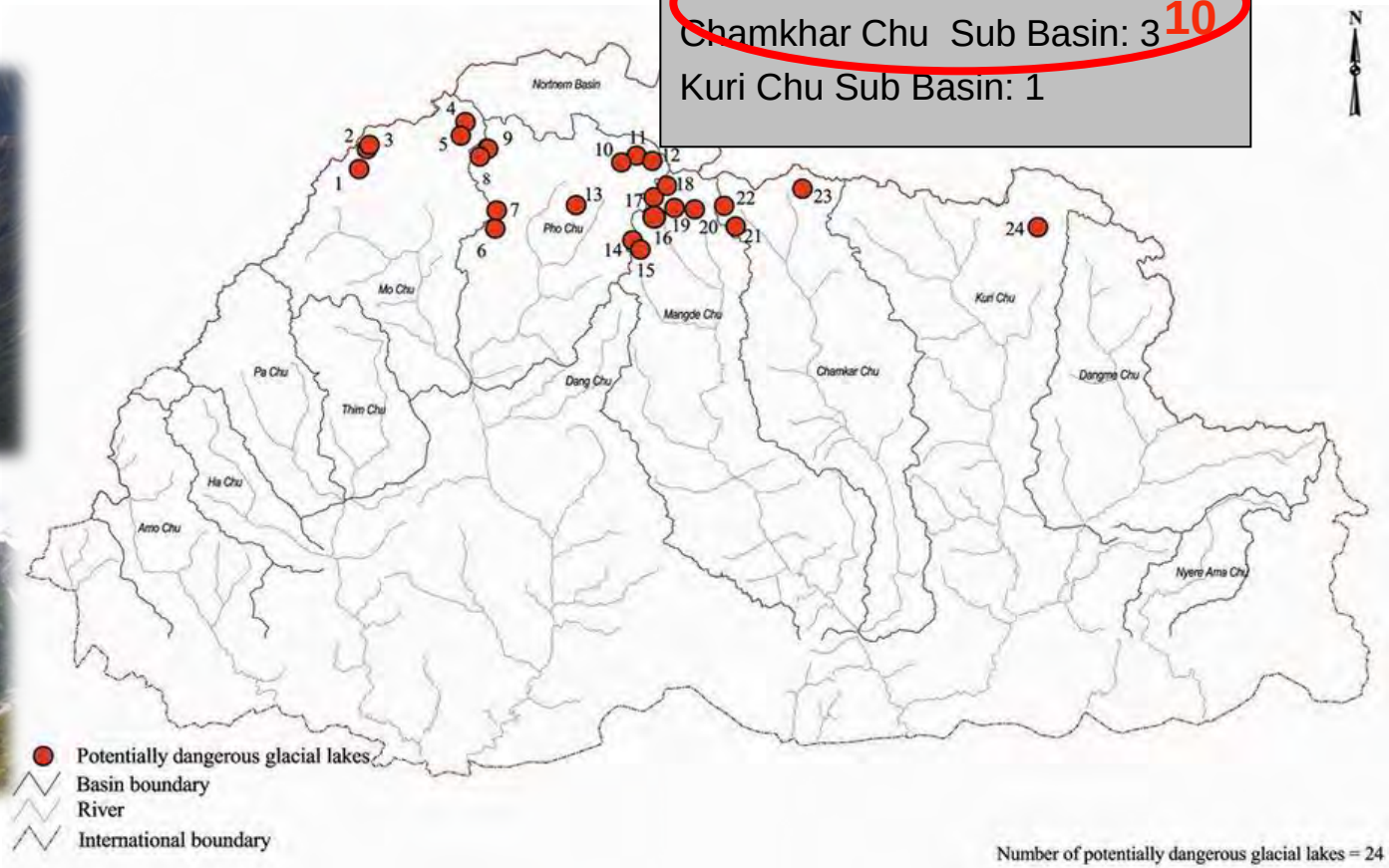


Map : Settlement point data of Bhutan (NSB, 2005)



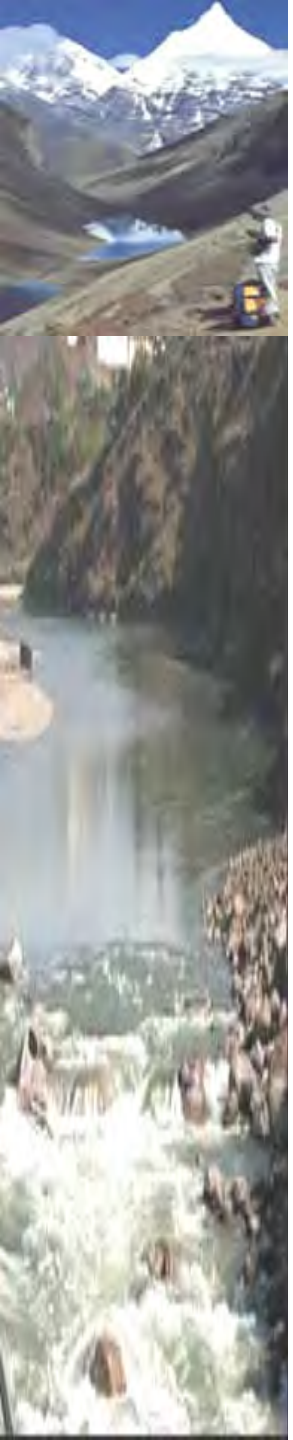
Potentially dangerous glacial lakes of Bhutan

Pho Chu Sub Basin : 9
Mo Chu Sub Basin : 5 — 14
Mangde Chu Sub Basin: 7
Chamkhar Chu Sub Basin: 3 — 10
Kuri Chu Sub Basin: 1

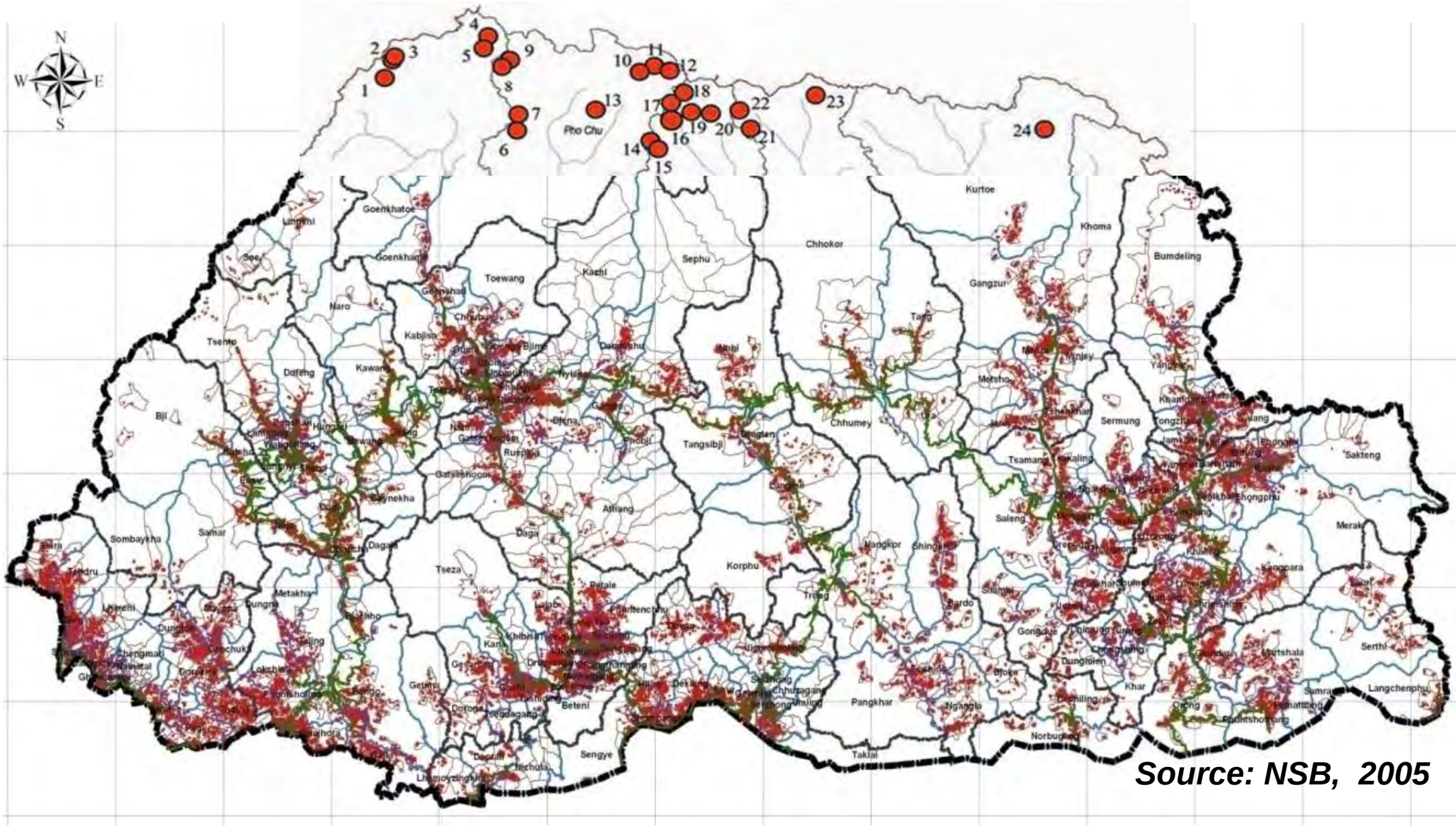


Out of 2674 glacial lakes, 25 has been identified as potentially dangerous lakes.

Source: *DGM & ICIMOD publication*



GLOF RISKS

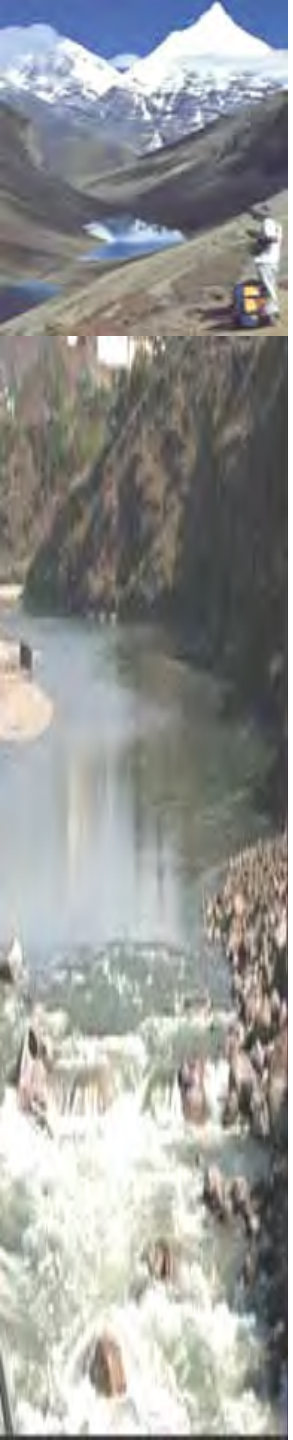


Source: NSB, 2005

Major hydro-met induced disasters in last 25 Years

- Six major events :
  - the 1994 Lugye GLOF,
  - the 2000 monsoon floods in Phuentsholing,
  - the 2004 eastern Bhutan monsoon floods,
  - the 2009 floods induced by Cyclone Aila,
  - the 2015 Lemthang Glacier Lake outburst flood, and
  - the 2016 Southern Bhutan monsoon floods.
  - ----------

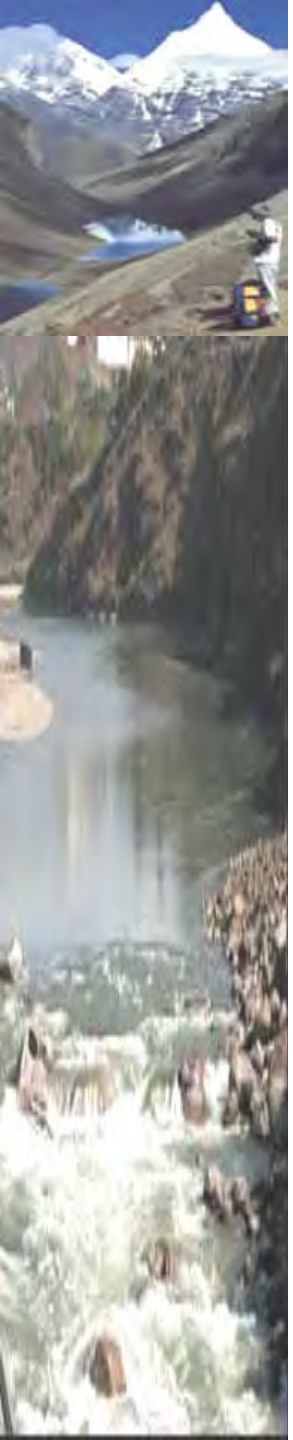
1994 GLOF Impact downstream



Punakha Dzong three days after the disaster of 1994. Also shown is the confluence of the Phochu and the Mochu below the Dzong and scars of the back flow water after it had joined the Mochu and dammed the flow above the Dzong.

28 June, 2015 GLOF from Mochhu

- Outburst of Lemethang Tsho *(Mo-gl200)* located at the base of Ganchen Tag Mountain, head water of Mochhu



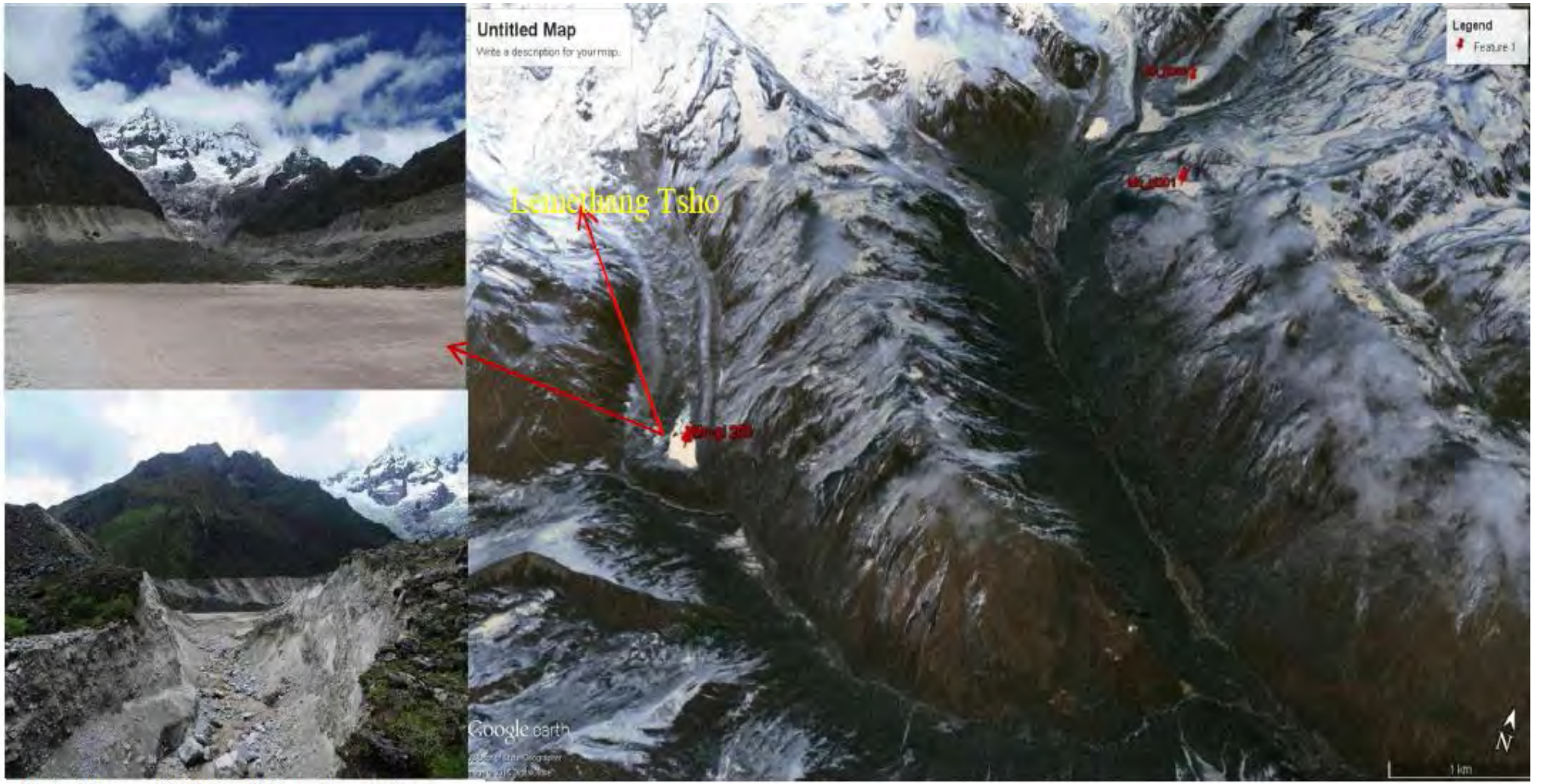
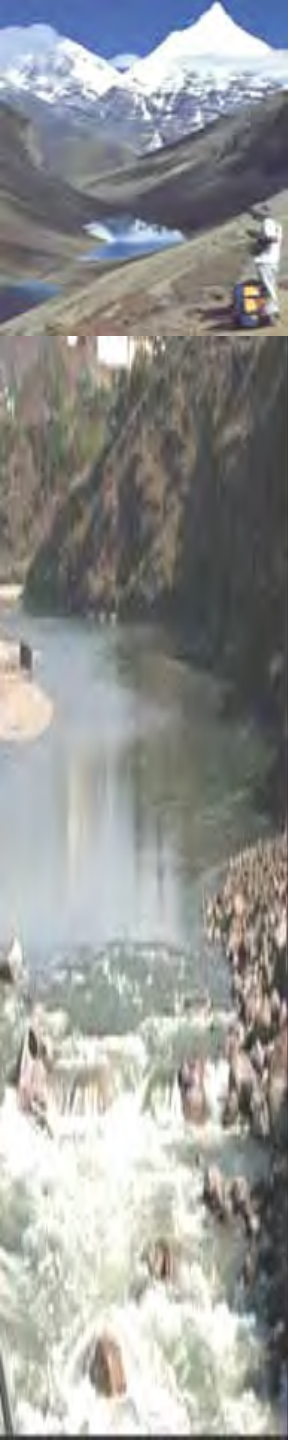
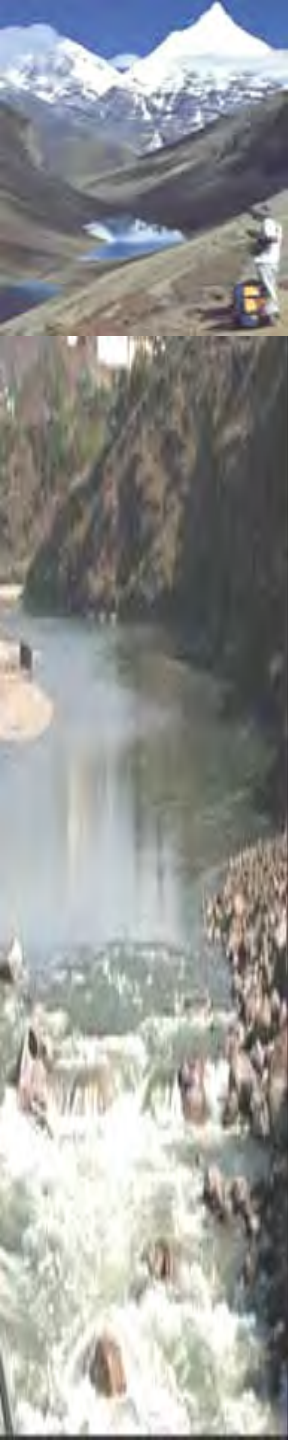


Photo Source JDNP Staff(Gasa Dzongkhag)

Flash Floods Impact



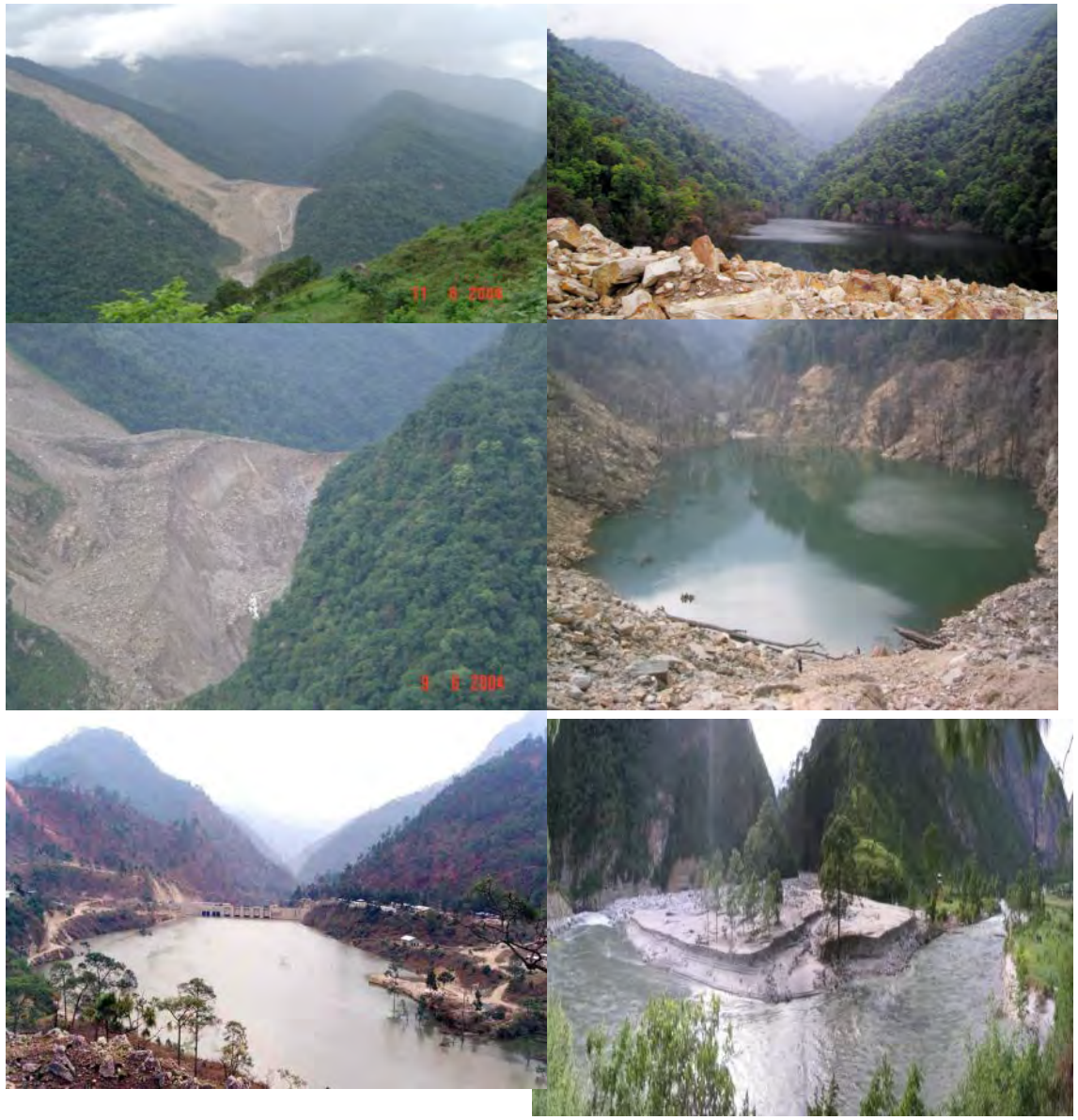
Thimchhu flood during cyclone Aila May 2009



Landslide Dam Outburst Flood (LDOF)

Tsatichhu 2004

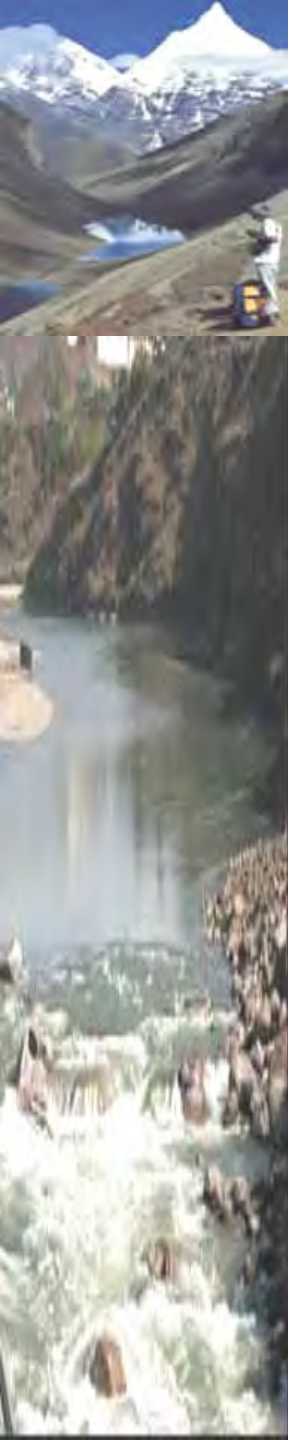
- ✓ Landslide Dam was formed in September 2003
- ✓ Dam burst its banks in July 2004 releasing about 6000 cubic meters per second.
- ✓ Monitoring and Early warning system safe 60 MW Kurichhu Hydropower Plant down stream



Mochhu Landslide Dam

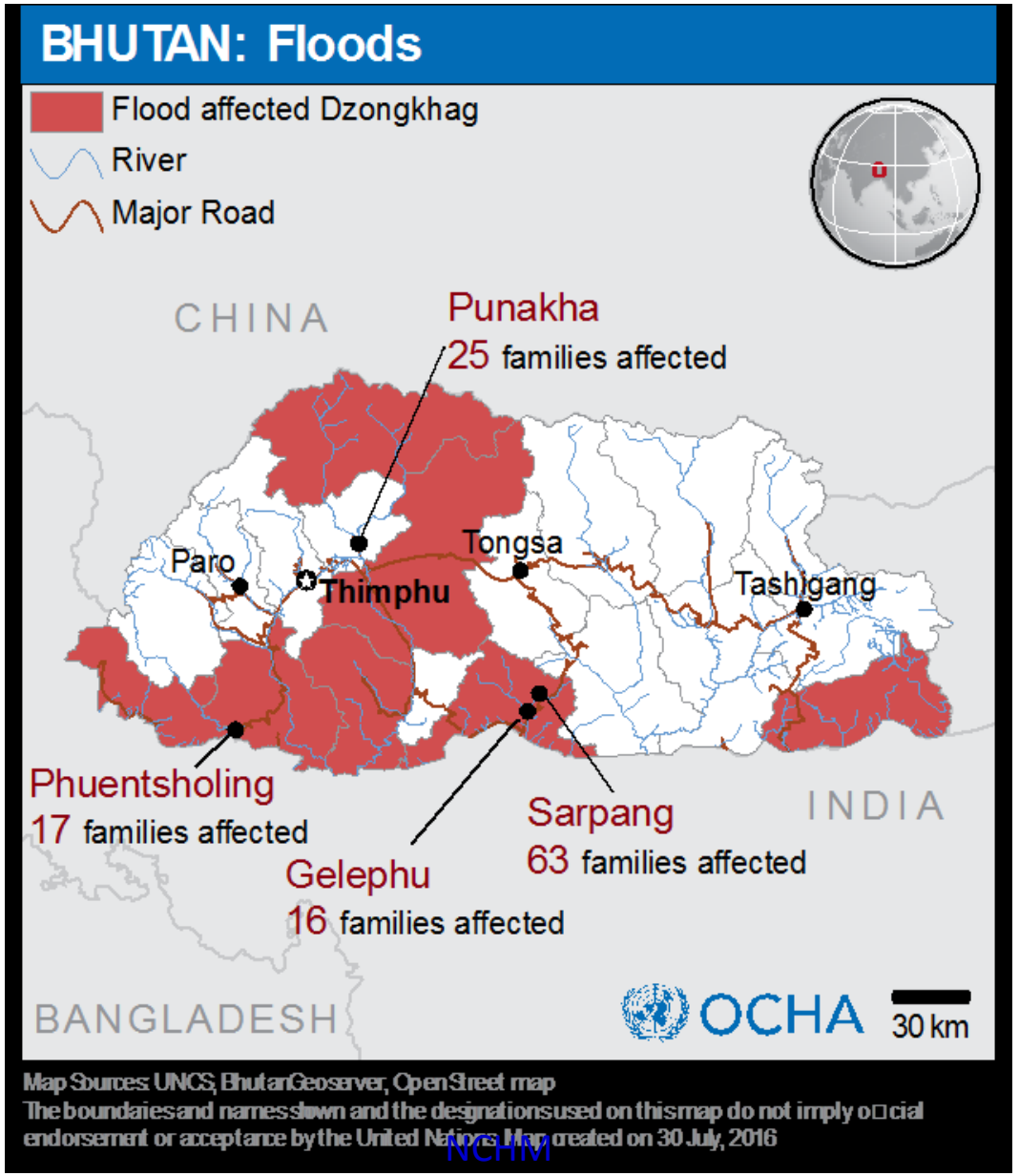
- Formed on 23 August 2012 after 21 June 2012 Mochhu Flood,

Photo Courtesy @ Karma Dupchu, 2012



Flash Flood July 2016

- 63 in Sarpang Market (21 of which have been relocated);
- 16 in Gelephu (two of which have been relocated);
- 17 in Phuentsoling;
- 25 in Punakha; and the remainder in other locations.

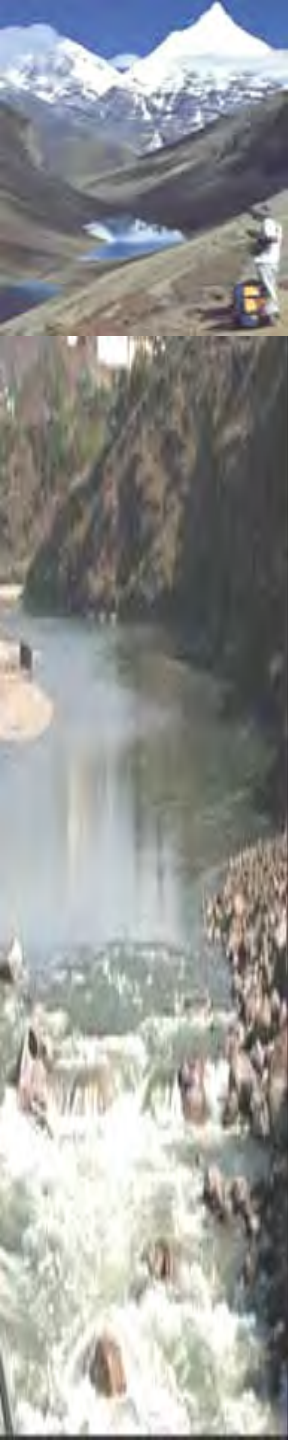


NCHM

National Center for Hydrology and Meteorology

Challenges and lessons learned

a. Geographical terrain
b. Sustainability of observation network and infrastructures;
c. No dedicated Center HQ Office and related facilities (Calibration lab, Communication etc.)
d. Limited access to new technologies and its application
e. Limited Professional Capacity;
f. Difficult to provide reliable weather and hydrological forecast due to natural topography;
g. Flood/GLOF EWS is based on flood detection system rather than forecasting
h. Lack of proper database management system
i. Short time series historical record for climate projection studies
j. Technical cooperation



VISION

Center for Excellence in Hydrology, Meteorology and Cryosphere Science and Services.

GOALS

a.Improve result-based decision support service for weather incidents and events that threaten lives and livelihoods;

b.Enhance climate services to understand and adapt to climate-related risks;

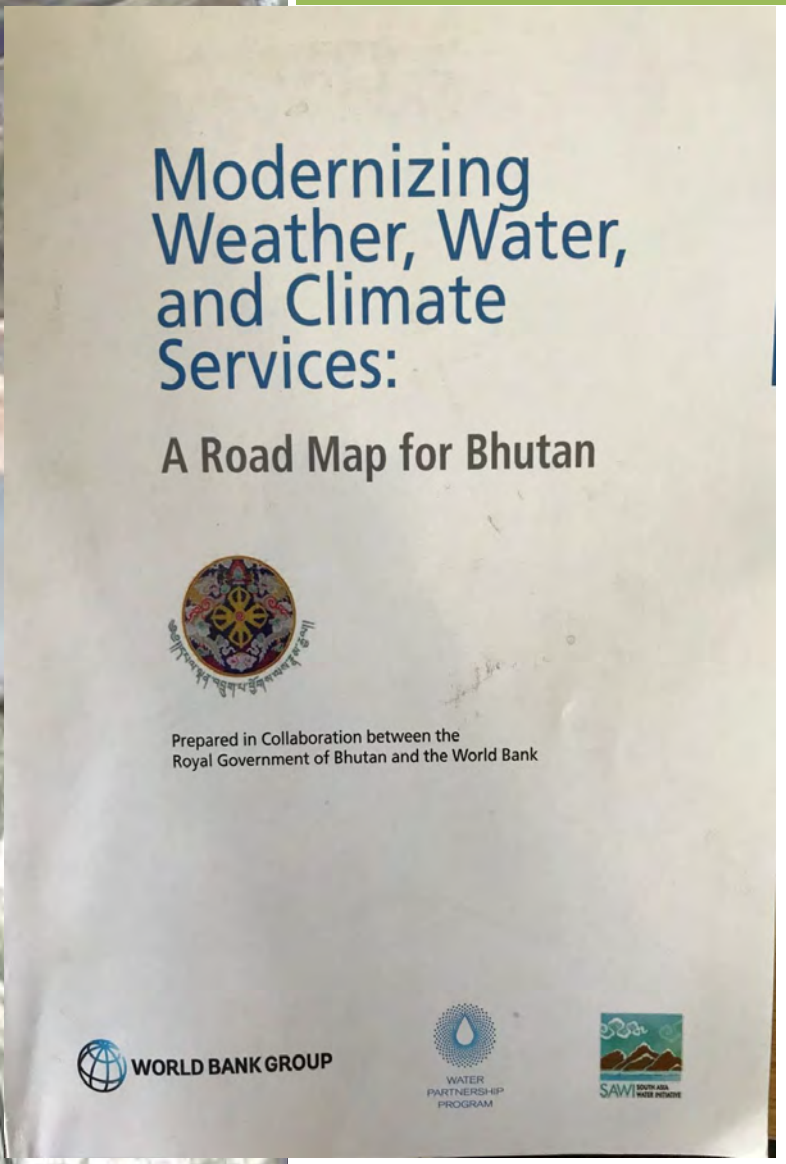
c.Develop capacity to provide integrated and coupled monitoring, detection and forecast services to support assessment and management of water resources and water-related hazards;

d.Build competence to provide sector-relevant information for socio-economic development, and support development of integrated environmental services to foster healthy communities and ecosystems;

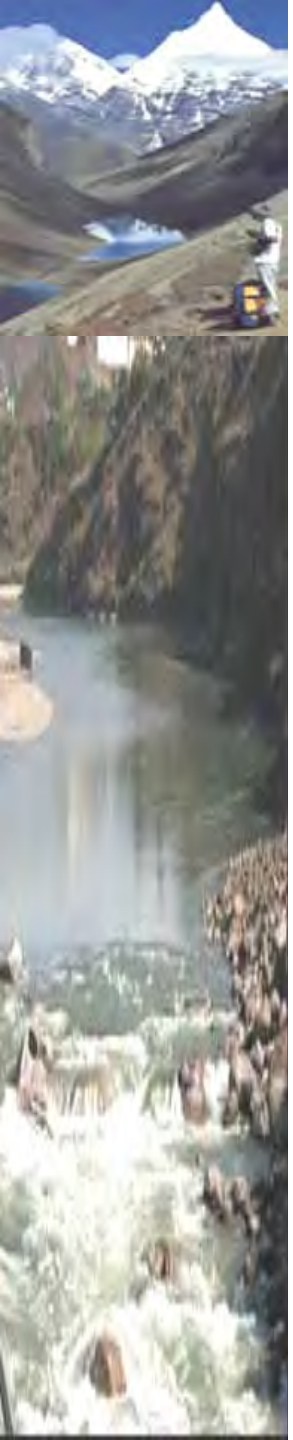
e.Sustain highly skilled professional workforce equipped with training, tools and infrastructure to fulfil the mission.

MODERNIZATION ROAD MAP

Short term (1-2 years)



a. Prepare Stratgic Plans based on users needs;
b. Strengthen sectoral collaboration and partnership;
c. Strengthen national level organizational profile;
d. Develop training plan and staffing;
e. Develop regional collboration plans (like MoU RIMES)
f. Develop education and awareness programs for (School, local governments and communities);
g. Prepare plan to enhance priority monitoring/observation system based on sectoral needs;
h. Climiate Projection of Bhutan



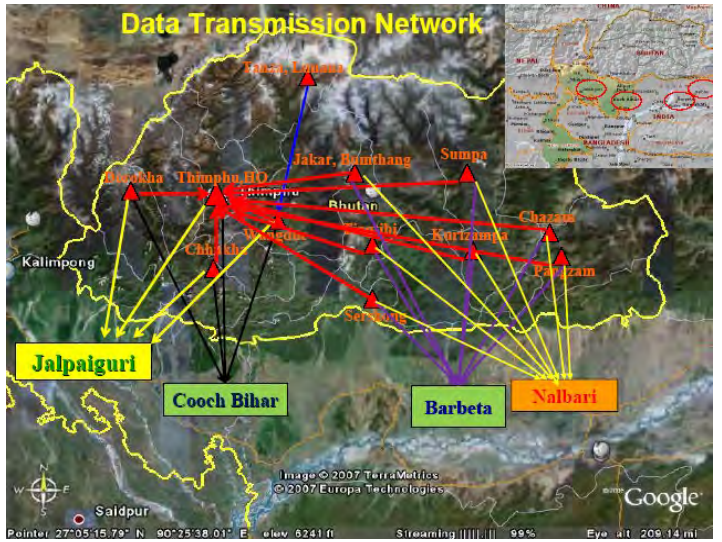
MODERNIZATION ROAD MAP

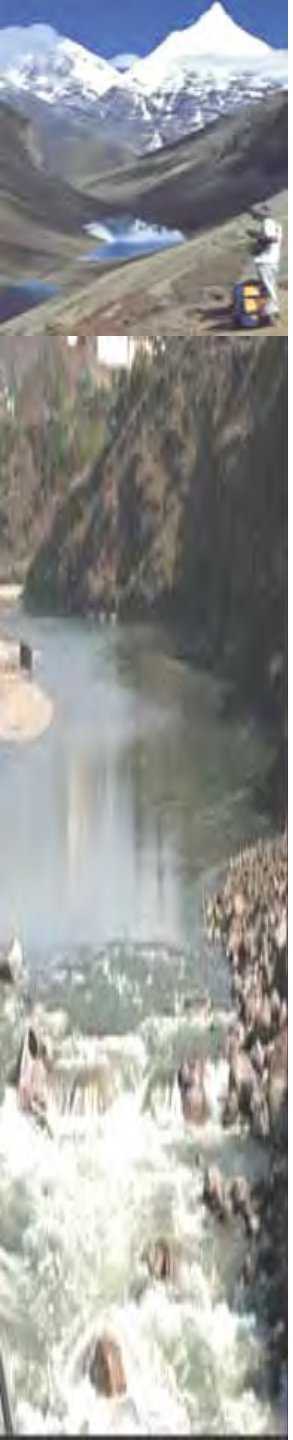
Medium Term (2-5 Years)

a. Develop Policy and legal framework (Hydromet Policy)
b. Strengthen Infrastructure and ICT facilities (NCHM HQ and Facilities)
c. National Water Resources Assessment;
d. End-to-end early warning systems;
e. Enhance Observation network based on the sectoral needs
f. Establish Regional Offices to ehanhce service delivery;
g. Improve Agromet and Aviation meteorological services
h. Strengthen sector specific climate services (Partnership)
i. Establish longterm climate and cryosphere monitoring program

International and regional collaboration

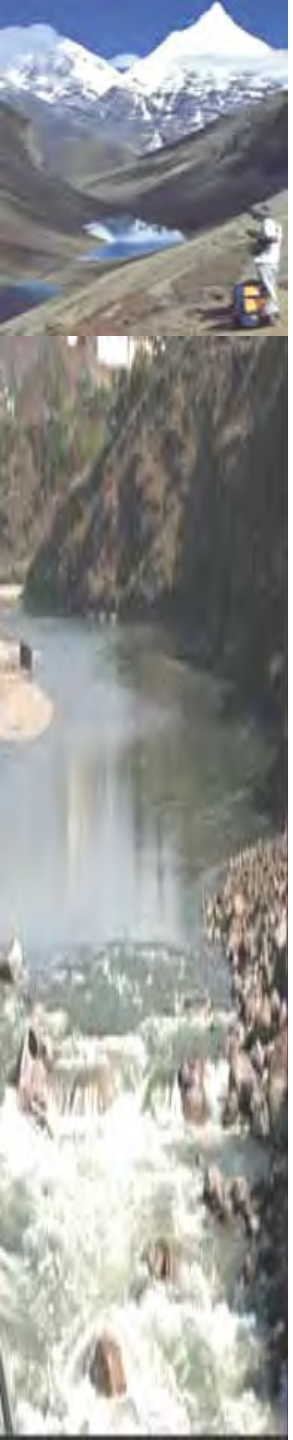
- WMO
- IPCC
- With Government of India
  - Extended weather forecast (IMD, MoES)
  - Capacity building (IMD, MoES)
  - Investment and sharing and exchange of hydro-met information for flood forecasting and warning (CWC, MoWR) South Asian Flash Flood Guidance (WMO/IMD..)
- With **ICIMODS** in the areas of : Cryosphere monitoring program, regional flood information exchange of hydro-met data;
- **RIMES** to provide technical backstopping , Capacity building services
- **SAARC/BIMSTEC** Centre on Weather and Climate (BCWC)





Role of Public/private sector and/or non-governmental entities

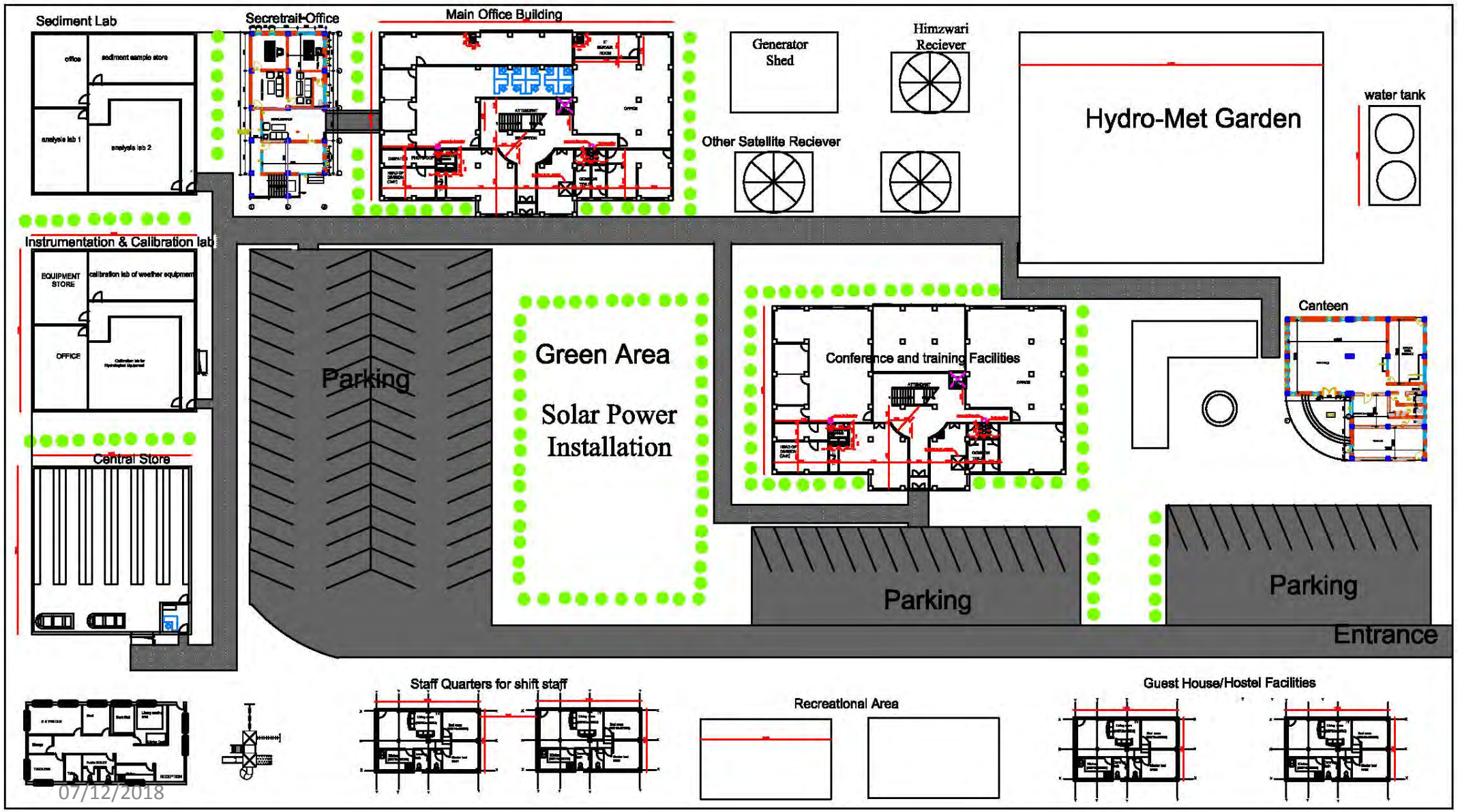
- Private sector/NGOS engagement is limited (Supply of equipment's..) but their participation is very important
  - Tour operators
  - Airlines
  - Hydropower Power
  - NGOs
  - Media etc.



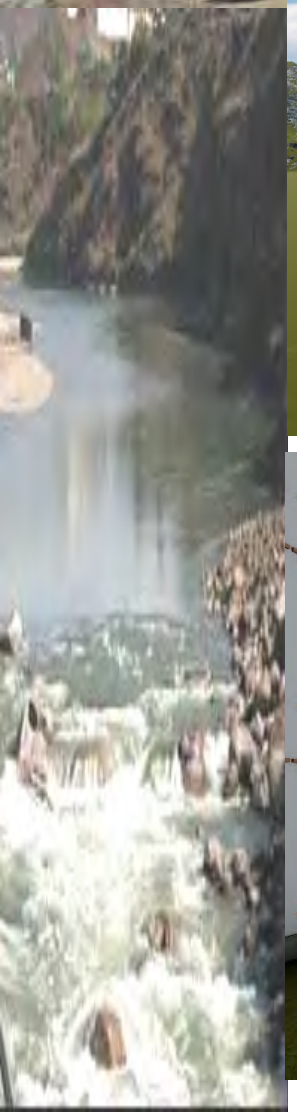
Linkages to National Goal (12 FYP-2018-2023)

National Goal	**GNH** **12 Five Year Plan:** **A Just, Harmonious and Sustainable Society**	
Objective	**Prepare and responsive society to hydrometeorological threats and benefits through provision of decision support services on weather, climate and water resources**	
NKRAs	*Outputs will contribute indirectly to almost all the 16 NKRAs and is directly linked to NKRAs 6 and 8.*	
	NRKA 6: Carbon Neutral, Climate and Disaster Resilient Development Enhanced	NKRA 8: NKR Water, Food and Nutrition Security Ensured
SKRA	1.1 End to end National Framework for Climate Services	2.1 Access to hydrological information and understanding of national water availability improved
	1.2 Hydro-meteorological and Cryosphere Disasters Assessed and Reduced	2.2 Water quality improved
Programme	**Programme 1: Weather and Climate Services for Building Climate Resilience**	**Programme 2: Enhancing Hydrology, Cryosphere and Water Resources Information and Early Warning Services**

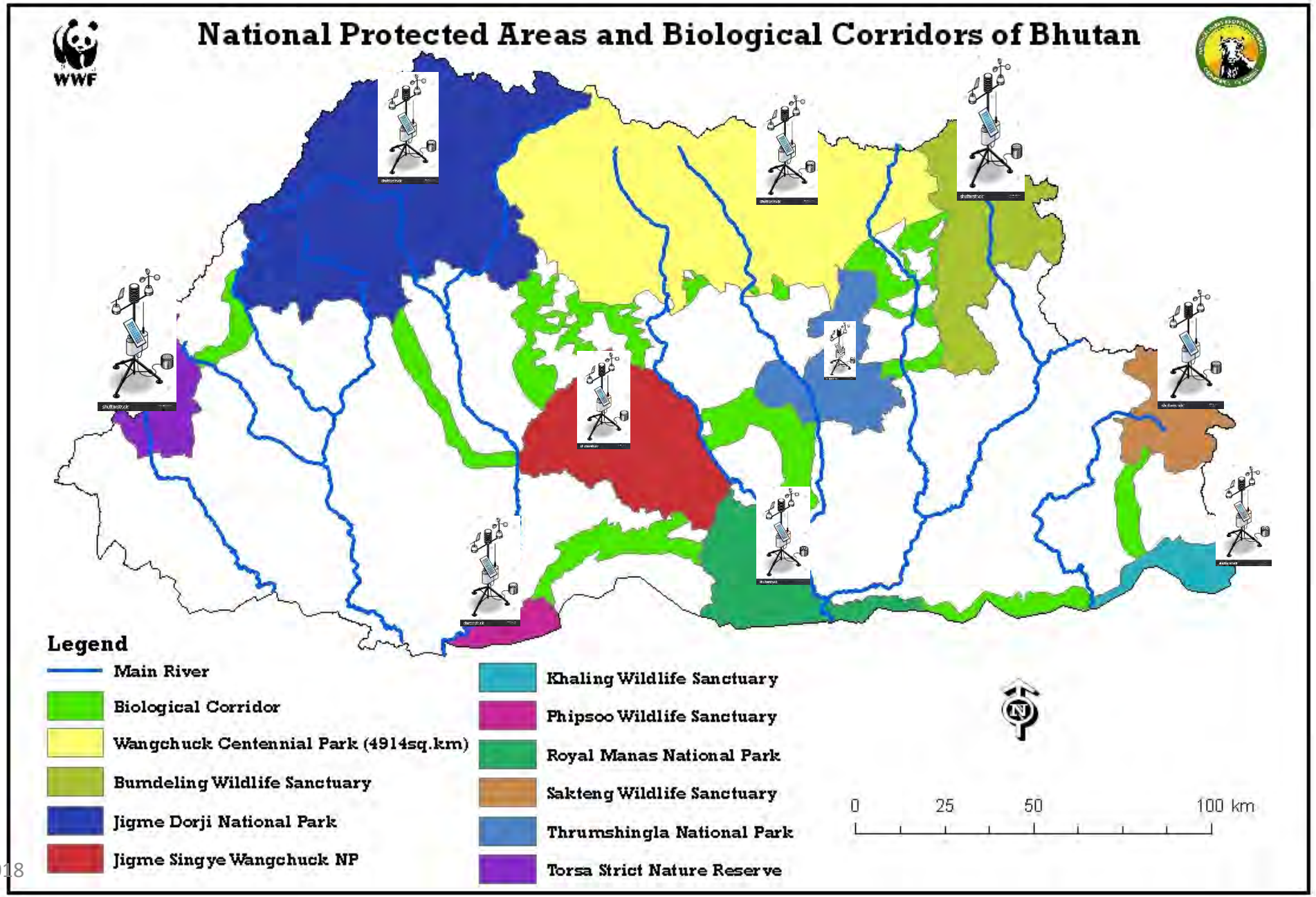
NCHM HQ and Facilities Plan



NCHM HQ and Facilities Plan



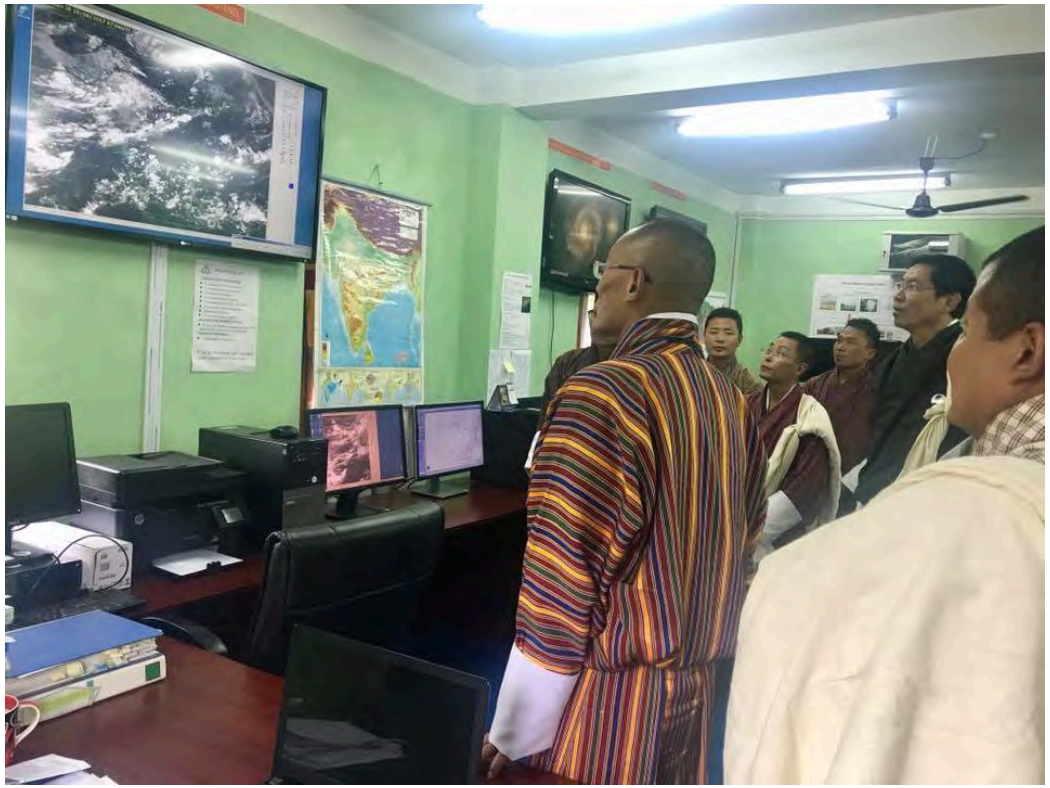
Long Term Climate Monitoring Program in Protected Areas



Leadership and Good Governance

Leadership

Good Governance



"If you want to know your past life, look at your present condition.
If you want to know your future life, look at your present actions."

— Padmasambhava

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Thank you very much !

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Face book:
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Four Harmonious Friends

- Is one of the most universal and beloved tales in Bhutan. The image of a bird, rabbit, and monkey standing on each other's shoulders on the back of a patient elephant portrays social and environmental harmony. Paintings of the "Four Harmonious Friends" appear in Bhutanese homes and in official and other public buildings.
- As the story goes, the bird finds a seed and plants it. Then, the rabbit waters it, and the monkey fertilizes it. Once the seed sprouts and begins to grow, the elephant protects it. After some time, the small plant grows into a big, beautiful tree full of healthy fruit. By working together and using their individual talents, the four friends are able to reach and enjoy the fruits.

Source: https://folklife.si.edu/resources/pdf/Signs/Bhutan/BH_PRG_03.pdf